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Investigating Self-Regulated Learning, Motivation, and Test Anxiety to Effectively Support Hispanic/Latine/a/o/x and Transfer Students via Pedagogical Practices

Sierra Outerbridge, University of Central Florida

Sierra Outerbridge, M.Ed., is a graduate research assistant and Education (Learning Sciences) Ph.D. student at the University of Central Florida. Sierra earned her Bachelor of Arts degree from Samford University where she studied Spanish Language and Literature and Business, as well as a Master of Education degree in Curriculum and Instruction from the University of Central Florida. Her current research focuses on fostering self-regulated learning, technological innovation for student-centered learning environments, and strategic approaches to develop equitable educational opportunities.

Michelle Taub, University of Central Florida

Michelle Taub, Ph.D., is an Assistant Professor of Learning Sciences and Educational Research and Core Faculty of the Faculty Cluster Initiative's Learning Sciences Cluster at the University of Central Florida. Her research focuses on measuring self-regulated learning across research and learning contexts, such as STEM classrooms.

Dr. Sudeshna Pal, University of Central Florida

Dr. Sudeshna Pal is an Associate Lecturer in the Mechanical and Aerospace Engineering Department at the University of Central Florida (UCF), where she teaches courses in the areas of system dynamics, controls, and biomedical engineering. Her current research interest is engineering education, with focus on blended learning, project-based learning, and digital and design education. Her educational research is supported by grants through the National Institutes of Health and the National Science Foundation. She has published several pedagogical journal and conference articles. She received the Excellence in Undergraduate Teaching Award in 2020 and 2024, and the Teaching Incentive Program Award in 2022 at UCF.

Prof. Hyoung Jin Cho, University of Central Florida

Professor Hyoung Jin Cho is the Associate Chair of the Department of Mechanical and Aerospace Engineering at the University of Central Florida. He coordinates two undergraduate programs – B. S. Mechanical Engineering and B. S. Aerospace Engineering. He has published over 130 peer-reviewed journal and proceeding papers. He has 12 and 6 patents granted in the U.S. and Korea, respectively, in the areas of sensors, microfluidic devices, and micro/nanofabrication. His current research focus is on miniaturized environmental sensors and sample handling devices. He earned his Ph.D. in Electrical Engineering from the University of Cincinnati in 2002. He worked as Research Engineer at Korea Electronics Technology Institute (KETI) from 1993 to 1997. He received the NSF CAREER award in 2004 and was given the WCU (World Class University) Visiting Professorship under the Ministry of Education, Science and Technology, Korea in 2009. He is currently leading the NSF-supported HSI IUSE (Improving Undergraduate STEM Education) Project: Enhancing Student Success in Engineering Curriculum through Active e-Learning and High Impact Teaching Practices (ESSEnCe). In this project, a team of faculty members collaborate to implement active learning and high-impact teaching practices in engineering gateway courses to enhance Hispanic/Latino transfer student success.

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Abstract

It is critical to consider students' self-reported learning experiences when educating future engineers, especially for students who are historically underrepresented and/or underserved. This empirical full paper seeks to understand how students view themselves as learners within the learning process, what their motivations are to learn, and how they report their test anxiety in context of their fundamental courses. These key insights are beneficial for educators to adeptly adapt pedagogical practices to support students' learning and improve learning outcomes. As a part of an NSF-funded grant to better support Hispanic/Latina/o/é/x and transfer students, we seek to interpret students' self-reported self-regulated learning (SRL), motivation (via achievement goal orientation and general self-efficacy), and test anxiety who completed several self-report questionnaires in their engineering courses over time. To foster SRL and motivation, while creating an environment to mitigate test anxiety, we implemented key pedagogical practices in their fundamental engineering courses. These practices include readily available lecture videos for mixed mode modality, mini projects, and multiple-attempt testing. 152 students (n=152) at a large southeastern Hispanic Serving Institution (HSI) in the United States in Spring 2024 in Dynamics, a fundamental engineering course, completed entry and exit surveys on Likert scales about their perceptions of each pedagogical practice, self-reported SRL, achievement goal orientation, self-efficacy, and test anxiety. Results suggest students' self-reported motivation and SRL change over time. In particular, some motivation constructs *decreased* over the course of the semester. As such, future work should aim to understand how we can foster mastery goal orientations, which are often associated with deeper learning. Further, it is important to investigate test anxiety for all students, but in particular, with historically underserved undergraduate engineering students in mind.

Keywords: undergraduate pedagogical practices, self-regulated learning, motivation, transfer students, Hispanic/Latina/o/é/x students

Introduction

When considering challenging fundamental undergraduate engineering courses, it is important to identify ways in which we can create equitable environments that foster learning, supports students, and meets the learning outcomes. When developing equitable environments, addressing the needs of historically underserved and/or underrepresented students creates an opportunity for *all* students to gain the tools and experiences they need to find success in these challenging courses. As fundamental engineering courses are often viewed as difficult and are taken after pre-requisites, we seek to understand student perceptions in these courses to provide robust learning opportunities (e.g., implementation of pedagogical practices).

Though learning in all courses is important and foundational, these fundamental classes are uniquely positioned and beneficial for a student's understanding of engineering practice, providing a particular opportunity for us to understand how to best support engineering students. One way we believe we can best support students effectively and meet the learning outcomes is to foster self-regulated learning (SRL), where students maintain an active role in the learning process. Additionally, we seek to develop environments where a student can engage in healthy motivation practices in concurrence with SRL because a student will need to appropriately set goals and approach their learning in an adaptive manner. SRL can be fostered implicitly through various means, including via external factors that influence a student's ability to adopt adaptive SRL practices and encourage healthy mastery goal orientation/increased self-efficacy. Within this course, we implemented three distinct practices towards developing an environment that fosters SRL to empower students to be motivated to complete their work in order to deeply understand the material: multiple attempt testing, mini projects, and lecture videos.

Each of these practices allow students to reflect on their learning (i.e., discover what the need to adapt between test attempts), create metacognitive connections with past and future work (e.g., through mini projects), and identify concepts they need to practice further (e.g., via watching and practicing through lecture videos). Additionally, each of these practices promote student learning in a way that moves students towards learning and challenges. By implementing practices that focus on reflection and individual growth, we believe students will be able to foster adaptive learning practices.

Further, this research was conducted at a Hispanic Serving Institution (HSI) at a large southeastern university in the United States in service of an NSF grant (#2225208) focused on supporting Hispanic/Latina/o/é/x engineering students. With this in mind, we also focus this research study on the experiences of those students, along with transfer students who are historically underserved, towards understanding how we can develop curriculum to better support students in undergraduate engineering classrooms. We investigate Hispanic/Latina/o/é/x and transfer students' self-reported experiences over the course of semester, as student voice provides a perspective necessary to iterate and adapt best pedagogical practices. We acknowledge that these student populations are not monolithic [1]-[2]; however, we draw on our findings to better understand these populations towards developing curriculum practices to address needs of all students in undergraduate engineering courses.

This research focuses on student perceptions regarding three distinct pedagogical practices (multiple attempt testing, mini projects, and lecture videos), self-reported SRL, motivation, and emotion (as measured by test anxiety). We seek to develop environments and practices to foster adaptive strategies (e.g., reflection to modify study habits), including understanding students' self-reported motivation. SRL and motivation produce a reciprocal

relationship that should be further studied because they provide insights into the internal (e.g., emotions) and external (e.g., pedagogical practices) factors of a student's learning [3]-[4].

Theoretical Frameworks

In order to understand student learning in fundamental undergraduate engineering courses, we focus our research on SRL, which is a cyclical process in which a student gains the skills necessary to learn independently and interdependently [3]. The pedagogical practices used are considered external factors that influence how a student fosters SRL, and motivation and emotion serve as possible internal factors a student engages when fostering SRL.

Information Processing Theory of SRL

The Information Processing Theory of SRL [4] is a cyclical process in which a student (1) identifies a learning task (e.g., studying for an upcoming test), (2) plans accordingly (e.g., determines when and how to study), (3) performs the learning task (e.g., engages in specific studying activities or taking the test), (4) and reflects in order to adapt appropriately to achieve their learning goals more effectively. This process is distinct for each student, but in general, students engage in this cyclical process to foster adaptive learning behaviors. In challenging courses in particular, it is important for students to develop the skills necessary to reach their learning goals, such as identifying ways to study in a manner that works well for them (e.g., creating practice tests).

Further, this theory posits there are internal and external factors contributing to fostering SRL [4]. Internal factors refer to intrinsic motivation, emotions (e.g., test anxiety), and goal setting. External factors refer to contributors to SRL that a student cannot control, often including the learning environment, pedagogical practices, life circumstances, and peer interactions. External factors are investigated by interpreting students' perceptions of each pedagogical practice as they seek to foster SRL. For example, multiple attempt testing (2 attempts per exam) permits a student to engage in self-reflective behaviors in between each attempt to identify (1) learning gaps and (2) study strategies that need to change in order to gain the desired performance outcome. Students are not required to take the second attempt, but those who choose to take the exam again are able to have an opportunity to adapt according to their personal learning needs. Mini projects are periodic throughout the semester and allow students to understand the principles of Dynamics in our 3D world after solving the assignment analytically. Additionally, lecture videos provide students with the opportunity to initially engage with the material prior to the lecture, while also giving students a chance to reflect and review specific information they need to be successful in the course. Each of these practices help students engage in adaptive learning behaviors towards fostering SRL.

For this research, when considering the internal factors of SRL, we investigate self-reported achievement goal orientation and self-efficacy as a lens for motivation, and we explore self-reported test anxiety as an emotion a student might engage.

Motivation & Emotion: Achievement Goal Orientation, Self-Efficacy and Test Anxiety

As SRL is often associated with goal-directed behaviors, we choose achievement goal orientation as one of our key interpretations of students' self-reported motivation. Additionally, achievement goal orientation is often used in academic settings and provides clear insights into how students might engage in motivation to achieve their desired learning outcomes [5]-[6].

Achievement goal orientation includes a 2x2 matrix of goal orientation type (*mastery* and *performance*) and valence (*approach* and *avoidance*) [5].

Mastery goals typically indicate a student deeply wants to learn the material for long-term understanding. These goals are also often associated with higher learning outcomes because a student is able to engage in the material at a deeper level through metacognitive reflection [6] and creating connections between present, past and possibly future material. Performance goals are often set when a student seeks to complete a learning task better in comparison to their peers. These goals are often linked to surface-level learning, where the focus is not on developing metacognitive connections but rather on achieving a specific score relative to peers [6]. The valence of approach refers to a student's willingness to engage in a particular learning behavior. Approach-oriented goals are associated with higher learning outcomes and higher self-efficacy because students set goals to achieve academic challenges [7]. Avoidance goals refer to students striving to meet expectations primarily to avoid failure or negative consequences.

Paired, this model creates four distinct orientations: mastery approach, performance approach, mastery avoidance, and performance avoidance. If students report high mastery approach, it suggests that the student seeks to master the material, and they often move towards challenges. These students desire to learn the material to develop deeper cognitive connections with the content, often for the purpose of integrating knowledge with their existing understanding of the material [8]. For example, a student studying for an upcoming test might practice the material of a challenging learning concept because they want to understand it for an upcoming internship, coupled with a desire to achieve a high score on the test. If a student reports high mastery avoidance, it suggests that a student wants to avoid failure when trying to master the content. A student might study for a test because they really want to understand the material, and they do not want to risk not understanding the information. These students might work through a 20-step Dynamics problem, realize something is not correct in step 16, and decide to review it from the beginning because they want to ensure they master the material. Students reporting high performance approach are willing to engage with difficult and challenging material, and they are motivated to do so because they desire to check it off a to-do list or they want to perform better in comparison to their peers. If the performance measure is an exam, students reporting a performance approach goal orientation will set goals to study with a competitive paradigm in mind and a focus on studying to achieve the best score in their course. Performance avoidance goal orientation suggests a student does not want to fail in comparison to their peers. Students setting goals for a course with a performance avoidance achievement goal orientation are studying with a short-term goal in mind, and these goal orientations are often associated with lower performance outcomes in comparison to students who report high mastery approach [6], [9].

As students are multi-faceted and dynamic individuals, this theoretical framework allows students to hold more than one goal orientation at a time. For example, the same student might report high mastery approach and mastery avoidance, suggesting that students might have more than one reason they set goals to learn the material in a particular course. Therefore, this model is highly appropriate when investigating students in Dynamics, a fundamental engineering course, where students might desire to master the content and simultaneously perform better than their peers as engineering is a highly competitive field [10]. Additionally, the multidimensional nature of achievement goal orientation [5] provides insights into goal setting as a student fosters SRL [6]; students might have various reasons to engage in planning or reflecting within the learning process, and achievement goal orientation allows us to interpret students' self-reported

motivation in the context of SRL while acknowledging varied reasons a student might be report higher levels of particular motivation orientations.

Self-efficacy serves as our second motivational lens to understand students' internal behaviors and beliefs. Self-efficacy refers to the belief a student holds regarding their ability to accomplish a particular task at hand, in this case, a learning task [11]. This motivational framework is particularly important for this learning environment because it is connected to higher self-reported SRL and achievement goal orientation [12]. For example, if a student reports high self-efficacy, they are likely to have higher SRL because they believe they can achieve their goals and effectively implement adaptations. Students with high self-efficacy will often engage in behaviors that allow them to achieve high performance outcomes [13]. The same is true for students who report low self-efficacy. If a student does not believe they will do well in a particular course, associations of lower outcomes emerge [14].

Finally, we explore test anxiety as a key component of students' experiences in a fundamental engineering course. Students often experience test anxiety within high-stakes or high-pressure courses. Test anxiety is defined as the tendency to assess test-like situation or evaluative environments as threatening, and therefore, as anxiety-inducing [15]. Test anxiety is examined as a self-reported experience that can change overtime, and it serves as a variable to provide insights regarding students' emotions when taking challenging courses. Additionally, test anxiety is associated with lower performance on examinations. We anticipate that having multiple attempts on tests can mitigate test anxiety overtime.

Brief Literature Review

Analyzing self-reported SRL, motivation, and test anxiety has been well-studied in context of each other [14], [16]-[19], but limited literature focuses on undergraduate engineering students. Oftentimes, there is a reciprocal relationship between SRL and motivation. For example, if students report high levels of SRL, there is often an association with higher mastery goals, self-efficacy, and learners' outcomes [20]-[23]. Present research in engineering reveals that grit, motivational beliefs, and SRL have a positive relationship with academic achievement when considering classrooms with civil engineering students [24].

We focus our work on historically underserved and/or underrepresented students in the engineering field, specifically Hispanic/Latina/o/é/x and/or transfer students. When considering the experiences of Hispanic/Latina/o/é/x students, it is important to first note that this population is not a monolith, and many students have varied experiences within this community [25]-[26]. To support students in undergraduate classrooms, we seek to utilize pedagogical practices to foster SRL [27]-[29] and engage healthy motivation orientations towards developing deeper connections with the material and improve learning outcomes (e.g., via multiple attempt testing). Presently, the literature utilizes robust qualitative research methods to uncover the experiences of Hispanic/Latina/o/é/x students, and we learn more about engineering identity formation within this community via this methodology [30]-[31]. Much of this identity formation occurs within the context of their learning environments, and therefore, we seek to create classrooms where students are able to foster individual adaptive learning processes (e.g., SRL) while also integrating the nuances of interdependence within the learning environment (i.e., via mini projects and lecture videos).

Similarly to Hispanic/Latina/o/é/x students, transfer students are not a monolithic group [24], and they matriculate to the university for myriad reasons, including, but not limited to, financial responsibilities, familial expectations, working while enrolled in school, etc. [32].

Therefore, we investigate transfer students' perceptions to better understand how to support those who attend the university, especially as there are two large 2-year colleges in the area where students start their college journey.

We investigate pedagogical practices such as multiple attempt testing, lecture videos, and mini projects because we seek to empower students to engage with the content in varied ways leading to meaningful learning that fosters SRL [33]. As transfer students often have distinct external factors impacting their experience in the classroom [32], we hope these practices will lead to a significant increase in self-reported SRL, self-efficacy, and mastery goal orientation within the semester.

Additionally, our research investigates each of these groups individually and together, providing further nuance into how Hispanic/Latina/o/é/x students might differ between transfer and non-transfer. Much of the present literature focuses exclusively on Hispanic/Latina/o/é/x or transfer students (e.g.,[34]-[35]), and we build on the present insights within literature to better support Hispanic/Latina/o/é/x Transfer students (HLT) (e.g., [36]-[39]).

Methods

At a large southeastern university in the United States, 152 students (n=152) in Dynamics (a fundamental engineering course) completed entry and exit surveys in the Spring 2024 semester. The questions were the same at the beginning and end of the semester to assess students' self-reported perceptions of pedagogical practices, SRL, motivation (measured by self-efficacy and achievement goal orientation), and test anxiety. After receiving IRB approval (#00004462), entry surveys were administered after the first attempt on the first examination of the semester, and exit surveys were introduced between the last test and the final exam. All students received the opportunity to fill out the surveys for 1 extra credit point. Students could receive extra credit by completing an alternative assignment that took approximately the same amount of time. Thus, the sampling method was convenience sampling for this quasi-experimental quantitative study. The sample includes students who responded to both entry and exit surveys.

To investigate students' perceptions of course activities, the professor developed three distinct questionnaires to explore each practice: multiple attempt testing, lecture videos, and mini projects. Students responded to a Likert scale from 1-5 (strongly disagree to strongly agree), and subsequently, divided by 5 to provide a continuous score. Multiple attempt testing (MAT) for this course is defined as up to two attempts per test. If students were satisfied with their score in the first attempt, they did not need to take the second attempt. Between attempts, students were able to review material and adapt practicing, as appropriate. Students were also able to meet with the supplemental instructor to gain further insights for the material. MAT was utilized to foster SRL by providing key opportunities for students to reflect on their learning between attempts to adapt their studying habits and practice. Lecture videos were intended to be watched before instruction. Students could refer to the videos throughout the semester to bolster their understanding of the material. As the material is embedded in their online learning management system (Canvas), students can easily access the material as the semester progresses. Lecture videos were implemented to promote autonomy and allow students to engage in study practices particular to their learning needs, including adapting their learning practices (i.e., SRL). Mini projects included assignments allowing students to work with small groups to visualize the principles learned in Dynamics. For many of the projects, students solve the question analytically and then will create a 3D model to analyze the results either graphically or physically. This process allows students to gain further insights regarding the logic behind the mathematical

processes learned in class (Appendix A). Mini projects are created to promote a deeper understanding of the material to foster metacognitive monitoring and knowledge formation. Table 1 demonstrates the descriptive statistics for each measure. To further ensure the validity of the professor-developed questionnaires, we conducted an exploratory factor analysis (EFA) followed by an item-analysis to provide a Cronbach's alpha.

First, the purpose of the initial test was to explore the factors underlying the responses to their self-perceptions. The EFA included all questions regarding MAT, lecture videos, and mini projects. Three distinct factors emerged, with items that correlate the highest suggesting there is a concept to tie them together. In this case, we infer that the different questions regarding each of the pedagogical practices are connected based on the correlations. Since each construct is meant to focus on each pedagogical practice, we then conducted an EFA with each measure to identify if there were any distinct factors that emerged within the constructs themselves. A maximum likelihood solution was selected, and linear transformation of the data followed for interpretation of the results. For the rotational procedure, Promax with Kaiser Normalization was selected because it assumes that nonzero correlations among the factors are plausible. Each pedagogical practice (MAT, lecture videos, and mini projects) only emerged with one factor when conducting EFA individually to test whether there were factors within each construct. This result is consistent with the theoretical formation of each questionnaire. To follow up the EFA since each measure only investigated the intended factor, we conducted an Item Analysis to test reliability, producing distinct Cronbach's alpha levels for each measure at entry and exit (Table 1). The Cronbach's alpha for each construct was very good to excellent, demonstrating that these measures appropriately and effectively analyze the intended information.

SRL and test anxiety were measured via two subscales of the Motivated Strategies for Learning Questionnaire (MSLQ) (Metacognitive Self-Regulation Scale: α =.79; Test Anxiety Scale: α =.80; [40]). The MSLQ is on a scale from 1-7 [Not true at all of me (1) to Very true of me (7)]. The scores for the MSLQ are then averaged (Table 2). The General Self Efficacy (GSE) Scale was used to interpret students' self-reported self-efficacy ($.76 \leq \alpha \leq .90$; [41] and is measured using a 4-point Likert of 1-4 [Not True at All (1), Hardly True (2), Moderately True (3), and Exactly True (4)] with a sum score for the measure (possible total of 40), and the total for each student was divided by 40 to provide a continuous percentage score for GSE (Table 2). The Achievement Goals Questionnaire – Revised (AGQ-R) provides a score for each of the component of achievement goal orientation: mastery approach (α=.84), mastery avoidance (α=.88), performance approach (α=.88), and performance avoidance (α=.94). Students responded on a 5-point Likert scale, averaged for each subcomponent of the scale, and divided by 15 to provide a continuous percentage (Table 2) [42].

		Minimum	**Maximum**	**Mean**	**SD**	α
Multiple attempt testing	Entry	.60	1.0	.920	.109	.940**
	Exit	.20	1.0	.930	.122	.941**
Lecture videos	Entry	.20	1.0	.759	.144	.856*
	Exit	.20	1.0	.775	.165	.914**
Mini projects	Entry	.20	1.0	.696	.148	.918**
	Exit	.20	1.0	.725	.166	.941**

Table 1. Descriptive statistics of pedagogical practices.
*Very good; **Excellent

		Minimum	Maximum	Mean	SD
SRL (α=.79)	Entry	.357	.940	.633	.109
	Exit	.369	.988	.638	.119
GSE (.76≤α≤.90)	Entry	.50	1.0	.789	.105
	Exit	.40	1.0	.799	.121
Mastery Approach (α=.84)	Entry	.40	1.0	.817	.133
	Exit	.33	1.0	.816	.143
Mastery Avoidance (α=.88)	Entry	.20	1.0	.787	.154
	Exit	.20	1.0	.758	.178
Performance Approach (α=.88)	Entry	.40	1.0	.831	.152
	Exit	.20	1.0	.789	.172
Performance Avoidance (α=.94)	Entry	.20	1.0	.821	.161
	Exit	.20	1.0	.782	.176
Test Anxiety (α=.80)	Entry	.143	1.0	.668	.221
	Exit	.143	1.0	.652	.205

Table 2. Descriptive statistics of SRL, self-efficacy, achievement goal orientation, and test anxiety.

Results

Research Question 1: Are there significant differences in students' perceptions of multiple attempt testing, lecture videos, and mini projects over the course of the semester?

A paired *t*-test was conducted to identify whether there were mean differences between entry and exit survey responses regarding the pedagogical practices over the course of the semester. All assumptions were met for the analysis. The analysis provides insights as to which practice was perceived as beneficial or efficacious.

The paired *t*-test revealed no significant differences for multiple attempt testing and lecture videos ($p>.05$). Further investigation of perceptions at the entry and exit survey time points demonstrates that the average score (out of a maximum of 1) for multiple attempt testing was .92 at entry and .93 at exit. Throughout the semester, students anticipated that multiple attempt testing would be beneficial, and at the end of the semester, students found it to remain helpful. The average perceptions of lecture videos were .76 and .79 for entry and exit surveys, respectively. Students, on average, agree that lecture videos are helpful, and overall, multiple attempt testing appears to be the most beneficial according to student perception.

For mini projects, students reported higher scores at the beginning of the semester compared to the end (t=-2.455, df=154, $p<.01$), suggesting adaptations might need to be implemented for mini projects towards meeting students' learning needs (e.g., deepening the understanding of the material through hands-on activities).

Research Question 2: How do self-reported levels of self-efficacy, achievement goal orientation, self-regulated learning, and test anxiety differ over the semester between Hispanic/Latina/o/é/x and non-Hispanic/Latina/o/é/x students, and between transfer and non-transfer students?

A repeated measures multivariate analysis of variance (RM-MANOVA) was conducted to investigate motivation, SRL, and test anxiety for Hispanic/Latina/o/é/x and transfer students over the course of the semester. Assumptions of equality of variance of error variances were met according to Levene's test ($p>.05$), and sphericity was assumed and met. The assumption of homogeneity was violated according to Box's M ($p<.05$), and Pillai's Trace is reported as it is robust to the violation of homogeneity [43].

The multivariate analysis revealed a significant between subjects interaction effect between Hispanic/Latina/o/é/x *and* transfer students (F=2.105, p<.05, V=.095). The univariate tests reveal significant differences for SRL (F=4.688, p<.05) and test anxiety (F=5.794, p<.05). The pairwise comparison demonstrates that students who do not identify as Hispanic/Latina/o/é/x reported higher levels of SRL than Hispanic/Latina/o/é/x students by .077 (p<.05). Further, non-Hispanic/Latina/o/é/x transfer students reported higher levels of self-efficacy by .087 (p<.05) and lower scores of test anxiety by .154 (p<.05) compared to Hispanic/Latina/o/é/x transfer students.

Additionally, some results included differences over time that were not delineated by demographic data. Over the course of the semester, within subjects effects demonstrated significant mean differences between self-reported mastery approach (F=6.091, p<.05) and performance approach (F=5.515, p<.05), in general. According to the pairwise comparisons, self-reported mastery approach and performance approach were higher at the beginning of the semester compared to the end of the semester by an average of .90 (p<.01) and .10 (p<.01), respectively. In particular for Hispanic/Latina/o/é/x students, both mastery approach and performance approach were reported higher at the beginning of the semester compared to the end by .114 (p<.05) and .149 (p<.05). These results demonstrate that, overall, students reported higher scores for mastery and performance approach at the beginning of the Spring term compared to the end, which could be a result of the approaching summer, but primarily reveals the importance of creating pedagogical practices to bolster mastery approach orientation throughout the semester.

Discussion and Pedagogical Recommendations

The first research question explores whether there were significant differences in students' perceptions of multiple attempt testing, lecture videos, and mini projects at the beginning and end of the Spring semester. The paired *t*-test analysis revealed no significant differences in perceptions of MAT and lecture videos between entry and exit surveys. Students consistently viewed multiple attempt testing as beneficial throughout the semester, as reflected in the high average scores (.92 and .93). These results encourage the continual use of multiple attempt testing. Regarding lecture videos, they were perceived as helpful, but future adaptations might need to occur to better support student learning. As the usefulness of mini projects decreased, it is important to consider adaptations to the mini projects, including increased timeline and fewer, yet more impactful projects, as they are currently implemented for every key concept.

The second research question was multifaceted and revealed nuanced results that encourage us to consider the learning needs of all students, including decreased self-reported mastery and performance approach over the course of the semester. As the semester continued, it is possible that students reported lower scores for mastery approach and performance approach, suggesting their desire to master the content and perform better in comparison to their peers diminished overtime. Additionally, these orientations are paired with the *approach* valence, which indicates that students reported lower scores when considering moving *towards* learning challenges. Future directions will include interviews to identify the sentiment behind the experiences of these students, possibly taking into consideration external and internal factors that could contribute to reporting lower scores. Further, we will explore the self-reported motivation in direct relationship with the perceptions of the activities, coupled with their outcomes on concepts learned via these pedagogical practices towards providing a more clarified view on the interactions between these practices and self-reported motivation.

The results of the second research question also reveal how we might best support historically underrepresented and underserved students, including Hispanic/Latina/o/é/x and transfer students. Within the results revealing decreased self-reported mastery and performance approach, Hispanic/Latina/o/é/x students emerged as a group who statistically significantly decreased their self-reported mastery and performance approach goal orientations. When considering best practices to support Hispanic/Latina/o/é/x, we seek to explore pedagogical practices that promote mastery approach goal orientations. In particular, we hope that multiple attempt testing coupled with adapted hands-on learning projects focused on topics of particular interest to the student will promote this goal orientation.

Hispanic/Latina/o/é/x students also self-reported lower scores for SRL and higher scores for test anxiety in comparison to students who identified as non-Hispanic/Latina/o/é/x students. To better support students in developing SRL skills, it is important the environment considers the learning needs of these students. For example, as Hispanic/Latina/o/é/x students do not have as much representation in comparison to non-Hispanic/Latina/o/é/x students within engineering, incorporating mentorship opportunities with engineers who reflect their identity can promote learning, including mastery goal orientation and reflection on one's own learning needs to reach their goals (e.g., SRL). Additionally, providing workshops to foster SRL explicitly within an engineering context might be beneficial to equip students with the tools necessary to learn interdependently through reflection and adaptation [3]. These workshops would benefit all students who choose to attend these sessions with the goal to provide resources to historically underrepresented and underserved students to learn the skills they need to thrive in the engineering classroom. Additionally, test anxiety was higher for Hispanic/Latina/o/é/x students. Test anxiety can be attributed to myriad internal and/or external factors that can cause a student to report higher levels of test anxiety. With this in mind, we consider the implementation of peer networking and mentorship. For historically underserved populations (e.g., a university denoted as an HSI), mentorship serves as a key component for developing the skills necessary to address high stakes challenges and testing environments [44]. Since MAT is highly perceived, we anticipated it would lower self-reported test anxiety. However, test anxiety remained relatively static, suggesting more integrated and multidimensional approaches might need to be implemented systemically.

When considering the transfer student population who responded to these surveys, there was a difference between non-Hispanic/Latina/o/é/x and Hispanic/Latina/o/é/x students. Transfer students often enter the learning environment with varied needs and responsibilities external to their learning (e.g., familial expectations [24]). According to students' self-reported perceptions for this Dynamics section, non-Hispanic/Latina/o/é/x transfer students reported higher levels of SRL and self-efficacy than Hispanic/Latina/o/é/x transfer students. These results suggest that some transfer students report having SRL skills and the belief they can accomplish the goals set before themselves. If there is a discrepancy within these beliefs, it is important to consider both the environments and the preparation students have access to before they enter the university. Possible practices might include partnering with the local state universities from which the majority of students transfer. Partnership can include providing engineering mentorship with those who reflect the demographics of the HSI along with workshops between the university and state colleges to increase proximity to the learning environments and access to resources. Though this type of practice might be challenging to implement, the discrepancy between non-Hispanic/Latina/o/é/x and Hispanic/Latina/o/é/x transfer students should be further investigated

towards providing all students with the opportunity to effectively be supported to promote equitable learning environments.

Conclusion & Future Directions

This study highlights key findings regarding student perceptions of pedagogical practices and motivation in engineering education, with an emphasis on differences across demographic groups, specifically Hispanic/Latina/o/é/x and transfer students. MAT emerged as a highly valued practice, maintaining consistently positive perceptions throughout the semester. Lecture videos demonstrated perceptions that remained stable but revealed moderate efficacy. Mini projects saw a decline in perceived usefulness, necessitating refinements to better align with students' learning needs and goals. These refinements include adapting the mini projects for future implementation, including reducing the number of mini projects from each key concept to a few keystone lessons. Additionally, these changes might include introducing a scaffolded project focusing on a topic of interest to themselves, their families, or a community need, thus increasing student engagement, metacognitive SRL, and motivation by connecting academic content to personal and real-world contexts [45]-[46]. Coupling MAT with adapted, culturally relevant, hands-on projects may support the development of mastery approach goal orientation that self-reportedly declined for Hispanic/Latina/o/é/x students. Further, the findings point to the need for targeted support for Hispanic/Latina/o/é/x students, who reported lower SRL and higher test anxiety. Suggestions included implementing mentorship opportunities with engineers who reflect their identities, along with SRL-focused workshops tailored to engineering contexts, can empower these students to navigate challenges effectively. For transfer students, the disparities between Hispanic/Latina/o/é/x and non-Hispanic/Latina/o/é/x populations in SRL and self-efficacy require further attention. Partnerships with local community colleges and universities, as well as initiatives to increase representation and access to resources, could bridge these gaps and promote equitable learning outcomes.

Future directions are multi-pronged as we deepen research efforts to interpret students' learning needs and gradually adapt pedagogical practices to promote retention, SRL, mastery approach, and self-efficacy. To further investigate, we seek to include qualitative research opportunities to explore how students experience the present pedagogical practices, how they reflect on their learning, and what motivates them throughout the semester. By hearing and learning about students' experiences, we can provide further insights coupled with the quantitative data we have collected. Additionally, we seek to adapt pedagogical practices gradually and implement best practices beyond Dynamics within the engineering department.

These findings within this study emphasize the importance of designing inclusive and adaptable pedagogical practices to address the diverse needs of students in engineering education. Future research will explore longitudinal impacts of these interventions, as well as the interplay between motivation, pedagogical strategies, and student success across different demographics. By prioritizing equity and inclusivity, educators and institutions can create environments where all students are empowered to thrive.

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Appendix A

Lecture Videos

Q1_LectureVideos Please rate the following questions on a scale from 1-5, where 1 means "Strongly disagree" and 5 means "Strongly agree."

1. The lecture videos in the mixed-mode course are easy to watch.
2. The lecture videos improved my understanding of important course concepts.
3. The lecture videos helped me understand the major steps in the problem-solving process.
4. Having closed-captions in the lecture videos helped me understand the content better.
5. I feel like I have more control over my learning in the mixed-mode courses compared to similar courses taught face-to-face.
6. I feel I was engaged in the mixed-mode course.
7. I am very satisfied with the mixed-mode format in the course.

Mini Projects

Q2_MiniProjects Please rate the following questions on a scale from 1-5, where 1 means "Strongly disagree" and 5 means "Strongly agree."

1. The mini-project assignment stimulated critical thinking skills in me.
2. Doing the mini-project assignments improved my technical writing and presentation skills.
3. Irrespective of my grades in the class, I feel that by explaining my results and the findings in the project report and the video in the mini-project assignments, I learned the course concepts better.
4. The mini-project assignments helped improve my performance in this course.
5. The mini-project assignments encouraged teamwork outside the typical classroom setting and helped me build better relationships with my peers.
6. I am very satisfied with the mini-project assignments in this course.
7. I wish other courses also adopted the mini-project assignment format similar to this course.

Multiple Attempt Testing

Q3_MultipleAttempts Please rate the following questions on a scale from 1-5, where 1 means "Strongly disagree" and 5 means "Strongly agree."

1. The multiple attempts helped me take the exams with less stress knowing that I have other chances.
2. The multiple attempts gave me the opportunity to go back and learn the concepts better before my next attempt.
3. The multiple attempts gave me the opportunity to recognize my standing in the course before my next attempt.
4. The multiple attempts gave me the opportunity to recognize the amount of preparation I need before my next attempt.
5. The multiple attempt exams helped improve my performance in this course.

6. Irrespective of my grade in the class, I feel that the multiple attempt exams helped me learn the course concepts better.
7. I am very satisfied with the multiple attempt exam format in this course.
8. I wish other courses also adopted the multiple attempt exam format similar to this course.
9. I wish there were more multiple attempts for the exams in this course.