UNIVERSITY OF CALIFORNIA,
IRVINE

Student-Centered Instruction in Higher Education: Investigating the Behavioral, Academic, and Minoritized Student Perspective

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Education

by

Ashley Nicole Harlow

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2021

DEDICATION

To

my mother,

your support and love have made all the difference

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ACKNOWLEDGEMENTS

First and foremost, I would like to thank you mom. You worked countless nights as a single mother to provide for us. They were not in vain, and I am eternally grateful. Throughout my life you have been my role model, biggest cheerleader, and advocate. I appreciate everything you have done for me including the countless calls to figure out FAFSA, getting to the university at 5 AM to be in the front row of my USC graduation, and the many Edible Arrangements you have sent me throughout the years to cheer me on. You are the reason I am a strong woman today. I love you. Everything I have accomplished and will accomplish is because of you.

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VITA

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Harlow, A., Lo, S. M., Saichaie, K., & Sato, B. K. (2020). Characterizing the University of California's tenure-track teaching position from the faculty and administrator perspectives. *PloS one, 15*(1), e0227633.

Xu, D., Solanki, S., & **Harlow, A**. (2020). Stepping Stones or Roadblocks: The Impact of Two-Year College Entry on Baccalaureate Attainment and Labor Market Outcomes. *American Enterprise Institute*.

Xu, D., Solanki, S., & **Harlow, A**. (2019). Examining the Relationship Between 2-year College Entry and Baccalaureate Aspirants' Academic and Labor Market Outcomes: Impacts, Heterogeneity, and Mechanisms. *Research in Higher Education*, 1-33.

Under Review

Harlow, A., Buswell, N., Lo, S., Sato, B. (under review). Beyond pragmatism: Internal and external impacts of hiring tenure-track teaching faculty at R1 institutions. *Journal of Higher Education Policy and Management.*

Park, L., **Harlow, A.,** Sato, B. (under review). Looking Inside the Black Box of College Instruction: An Examination of In-Class Group Activities and Students' Perceptions of Learning. *Research in Higher Education.*

RESEARCH PRESENTATIONS

Paper Sessions

Harlow, A. N., Sato, B. (2021, Apr) *Exploring the Relationship Between Student-Centered Instruction, Classroom Space, and Students' Psychosocial and Motivational Outcomes.* [Paper Session]. Virtual AERA Annual Meeting.

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2021, Apr) *Beyond Pragmatism: Internal and External Impacts of Hiring Tenure-Track Teaching Faculty at Research-Intensive Universities.* [Paper Session]. Virtual AERA Annual Meeting.

Harlow, A. N., Sato, B. (2021, Apr) *"In the End, You Actually Remember Learning Stuff": First-Generation College Undergraduates Perspectives of Student-Centered Instruction.* [Paper Session]. Virtual AERA Annual Meeting.

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2020, March) *Latinx Student Perceptions of Student-Centered Instruction* [Paper Session]. National Association for Research in Science Teaching (NARST) Portland, OR (Conference Canceled)

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2019, July*) "Makes me think more": Student Perceptions of Learning in a Student-Centered Classroom* [Paper Session]. Society for the Advancement of Biological Education Research (SABER) Minneapolis, MN

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2019, March) *Investigating Change: Understanding the Administrator Perspective on the UC System Tenure-Track Teaching Position* [Paper Session]. National Association for Research in Science Teaching (NARST) Baltimore, MD

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2019, January) *Investigating Change: Investigating Change: The UC System Tenure-Track Lecturer Position* [Paper Session]. Society for the Advancement of Biological Education Research (SABER) Irvine, CA

Harlow, A. N., Buswell, N., Lo, S., Sato, B. (2018, July) *Who are the UC System's Tenure-Track Lecturers?* [Paper Session]. Society for the Advancement of Biological Education Research (SABER) Minneapolis, MN

Harlow, A. N., Farkas, G. (2018, April) *Academic and Behavioral Factors that Affect High School Graduation* [Paper Session]. AERA Annual Meeting New York City, NY

Poster Sessions

Harlow, A. N., Sato, B., Williams, M., Williams, A. & Denaro, K. (2020, Apr) *An Institutional Approach to Promoting Active Learning: Impacts on Instructional Practices and Student Outcomes* [Poster Session]. AERA Annual Meeting San Francisco, CA http://tinyurl.com/segrylb (Conference Canceled)

Harlow, A. N., Sato, B. (2018, January) *Gaining Insight into the UC System's Tenure-Track Lecturer Position* [Poster Session]. Society for the Advancement of Biological Education Research (SABER) Irvine, CA

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ABSTRACT OF THE DISSERTATION

Student-Centered Instruction in Higher Education: Investigating the Behavioral, Academic, and Minoritized Student Perspective

by

Ashley Nicole Harlow

Doctor of Philosophy in Education

University of California, Irvine, 2021

Distinguished Professor George Farkas, Chair

There is a need in higher education to improve STEM instruction to increase retention, particularly of minoritized students. Student-centered instruction (SCI) requires students to be engaged in the classroom and interact with their peers. Previous research has revealed the benefits of student-centered instruction (SCI) (Theobald, 2020). However, less is known about the relationship of SCI with outcomes other than course grades. Student perspectives of SCI teaching methods are also less prevalent in the literature. Additionally, much of the literature combines all minoritized students together from a variety of settings despite heterogeneous differences between types of university contexts and racially minoritized groups. Therefore, this dissertation focuses on assessing student perspectives of student-centered instruction which includes psychosocial and motivational perspectives and the perspective of Latine students in STEM courses.

Study 1 surveyed 57 STEM classrooms over the course of 5 quarters on relationship building, test anxiety, self-efficacy, and task value. Findings show that being in a SCI course increased peer relationships and increased self-efficacy. However, there was also an

increase in test anxiety in SCI courses. Findings also suggested that the more Latine students within a course with SCI decreased the level of test anxiety.

Study 2 investigated the academic course grade differences in four contexts: 1) SCI course within the student-centered building 2) SCI course within a traditional building 3) didactic course within the student-centered building and 4) didactic course in a traditional building. There were no significant grade differences in the different contexts. However, higher class size was related to lower course grades suggesting the learning environment plays a role in academic success.

Finally, Study 3 explored the minoritized student perspective of a student-centered course and the types of capital minoritized students may be able to utilize. Findings showed that Latine students expressed an appreciation to be able to work with students from a similar ethnic group. Latine students enjoyed being able to chat with peers with whom they can speak Spanglish and slang to better learn and explain themselves throughout the course. Additionally, students expressed appreciation for strong instructor facilitation of activities and having multiple avenues to learn the material.

Collectively, these three studies show that SCI benefits students beyond purely affecting their academic grades. In SCI courses, students have increased peer support and gained stronger self-efficacy skills which can translate to STEM persistence long term. Additionally, SCI courses give students the opportunity to use skills and assets they may never have been able to show in a traditional course. Incorporating SCI teaching methods can help create inclusive learning environments that encourage STEM student success.

CHAPTER 1: INTRODUCTION

In recent years, there has been a shift in college instruction from the Instruction Paradigm, where instructors orally deliver information to a Learning Paradigm, which emphasizes learning through student discovery and construction of knowledge (Barr & Tagg, 1995). This movement has led to a more student-centered approach, in essence, the focus moved from teaching to student learning (Huba & Freed, 2000). Rooted in constructivism, student-centered instruction (SCI) allows students to make sense of their learning through critical thinking, reflection, and responsibility (Serin, 2018). In practice, SCI includes teaching practices that incorporate increased peer interaction and engagement in the classroom (Collins & O'Brien, 2003; Dunlosky et al., 2013; Felder & Brent, 2009). SCI differs from didactic, primarily lecture-based instruction, where students' sole responsibility is listening to an instructor and taking notes (Froyd & Simpson, 2008). SCI traditionally has been commonly used in smaller courses in the humanities; however, it is gaining in popularity in science, technology, engineering, and mathematics (STEM) fields, which had traditionally preferred a more lecture-based style due to large class sizes. With this shift, it is essential to consider how student-centered instruction is implemented in STEM. Is it more effective than traditional instruction? For whom is SCI more effective?

Student-centered instruction and STEM student success

The President's Council of Advisors on Science and Technology (PCAST) called for a 33% increase of STEM graduates (2014). Systematic changes that incorporate halting current attrition is necessary to increase STEM retention. In fact, attrition plays a huge role in the lower STEM degree attainment for minoritized students. The National Academies of Sciences, Engineering, and Medicine (2016) found that in the beginning of college there were equal levels of interest in STEM majors among various demographic groups. However, the number of STEM degree completion after 6 years drops to 29% for Latine students and 25% for African American students. Additionally, these disparities in retention have been found to be one of the most urgent problems in higher education (Bensimon, 2005). One method to increase retention is the restructuring of courses to be more student-centered to reach more students, as opposed to bridge or other similar programs that have a positive impact on students but are not scalable.

SCI helps to mitigate opportunity gaps for STEM retention. More SCI has led to increases in exam performance that raised grades by half a letter and lowered the fail rate for courses (Freeman, 2014). Other studies have suggested SCI to be especially beneficial for minoritized student success. One meta-analysis of over 1500 papers found student-centered courses reduced academic disparities in exams and failure rates. On average, student-centered courses lowered academic disparities by 33% (Theobald, 2020). These findings suggest the benefits of SCI for minoritized students, but poses the question of which minoritized groups may particularly benefit? Additionally, aside from the academic benefits, there is little research present on non-academic relationships and SCI courses.

Why focus on Latine and first-generation college students?

Previous research suggests that minoritized student success increases with student-centered instructional strategies (Eddy & Hogan, 2014; Haak et al., 2011; Harackiewcz et al., 2016). These strategies include peer interaction, highly structured activities within the course, and the ability to increase faculty and student interactions. However, much of this research does not take into consideration the variation among minoritized students. Understanding different ethnicities and cultures' perceptions and academic outcomes are needed to fully understand how SCI benefits the different groups that would be considered URM students.

More importantly, college students' demographics have changed drastically. An increase in diversity, particularly of minoritized students, has occurred in the past decade. One of the largest groups to grow in higher education is the Latine student population. Latine students are the largest minority group in the United States (Pew Hispanic Center, 2009) and the fastest-growing ethnic group in the nation (US Census, 2008). Despite this increase, academic persistence rates for Latine students are lower than their White and Asian counterparts (McFarland et al., 2017). These changes in demographics create a wider variety of cultural values and beliefs that brings into question: to what extent is student-centered instruction useful for the Latine population?

Minority Serving Institutions—Hispanic Serving Institutions (HSIs)

With the growing Latine student population, more institutions are being designated as Hispanic Serving Institutions (HSIs) – institutions with over 25% of the student population being Hispanic or Latine (Garcia, 2019). These institutions are particularly interesting since much of the previous research on Latine students focuses on either an aggregate of all higher education institutions or examines Latine students in Primarily White Institutions (PWIs). Due to HSI's unique environment where a larger number of Latine students are enrolled, an increase of student engagement in the classroom using SCI may have differing impacts than if few Latine students were present in the class. Little is known about Latine student success in HSIs with additional calls to action to increase research on Latine students in STEM fields and on participation and engagement in the classroom (Crisp & Nora, 2012).

Three-Study Dissertation Goal

To address the gaps in the literature, the following chapters, one for each study, addresses the following: 1) psychosocial and motivation outcomes related to SCI 2) academic disparities of minoritized students related to SCI 3) minoritized student perspective of an SCI course. Each chapter has a brief introduction to the study, the theoretical framework and existing literature section, method, results, and conclusion. Study 1 aims to compare the psychosocial and motivational perspective of students in a SCI course rather than a didactic course. Study 2 aims to compare academic disparities in STEM courses. Study 3 aims to honor the minoritized student voice of SCI courses. The findings from this dissertation will contribute to the literature by highlighting the benefits that go beyond academic course grades.

CHAPTER 2: STUDY 1—Student Perceptions of Psychosocial and Motivational Outcomes when in a Student-Centered Course

Historically, science classrooms have employed a pedagogy that is competitive and individualistic, which has been a contributing factor to certain groups not persisting in STEM (Shapiro & Sax, 2011). These groups particularly include Latine students who are severely underrepresented in the STEM field (National Academies of Sciences, Engineering, and Medicine). Laird, Garver, and Niskodé (2007) found that, on average, STEM faculty spent 16% more time lecturing and significantly less time using student-centered practices compared to faculty in the humanities. STEM courses tend to be taught in large lecture halls with little collaborative work and a curved grading scale, which reinforces the idea that individuals are solely responsible for their own learning of the material (Seymour et al., 1997). This competitive culture misses the fact that many students' identities do not align with such values and thereby leads to STEM attrition (McGee, 2020). However, more student engagement in the classroom besides solely didactic (i.e., lecture-based) instruction may be particularly crucial for reinforcing a student's decision to remain in STEM (Hyde et al., 2000; Margolis et al., 2000). Instructional practices that focus on the learner and incorporate increased peer interaction and engagement in the classroom are known as student-centered instruction (SCI) (Collins & O'Brien, 2003; Dunlosky et al., 2013; Felder & Brent, 2009). Didactic instruction differs from SCI because the students' sole responsibility is listening to an instructor and taking notes (Froyd & Simpson, 2008). These passive learning methods, coupled with limited faculty support and encouragement not only contribute to lower levels of STEM persistence, but also to a decrease in students' confidence that they can be academically successful (Ellis et al., 2016).

In fact, recent research has highlighted a growing need to understand how a student's culture and identity impact their learning (National Academies of Sciences, Engineering, and Medicine, 2018; Santiago & Soliz, 2012). Presently, there is literature on gender identity in STEM persistence. For example, research shows that women in STEM value collaboration, but the competitive nature found in STEM courses prevents them from building necessary relationships and deters them from the discipline (Astin et al., 1996; Kinzie et al., 2007; Margolis et al., 2000; Seymour et al., 1997). Furthermore, there is little research on how race/ethnicity impacts learning. Previous studies have made assertions that to promote more diversity within the STEM discipline, a more inclusive culture that appreciates differences and allows for collaboration is necessary (McGee, 2020). Physical classroom space that encourages peer and instructor interaction by its design can also contribute to more opportunities for collaboration (Strange et al., 2001). These findings of the need for instructional changes such as the increased implementation of collaborative learning extend to community-oriented cultural groups, including the Latine student population.

With the growing Latine student population, more institutions are receiving the designation of Hispanic Serving Institutions (HSIs) – HSIs are institutions with over 25% of the student population being Hispanic or Latine (Garcia, 2019). HSIs are particularly interesting since they enroll 67% of all Hispanic undergraduates in higher education while only making up 17% of eligible colleges and universities (Cuellar et al., 2020). However, much of the previous research on Latine students focuses on either an aggregate of all higher education institutions or examines Latine students in Primarily White Institutions (PWIs). Due to the unique environment of HSIs where a larger number of Latine students are enrolled, an increase of student engagement in the classroom using SCI may have differing impacts compared to courses in institutions where Latine students make up a much smaller fraction of the student body. Due to less research focused on HSI environments, there have been growing calls to action to increase research on Latine students in STEM fields and their participation and engagement in the classroom within HSIs (Crisp et al., 2012).

It is hypothesized that Latine students may disproportionately benefit from collaborative learning, due to the increased value of community in the Latine population compared to majority populations (Desmond & Turley, 2009; Oyserman, 2002). This study emphasizes how beneficial collaborative learning can be for students whose values are aligned with familial and collaborative practices, rather than the individualistic and competitive cultures present in STEM disciplines.

Conceptual Framework: Collaborative Learning

Collaborative learning is one of the cornerstones of student-centered instruction (SCI) and supports a shift from focusing on teaching to student learning. The collaborative learning framework encompasses the idea that students learn when they are actively engaged within the classroom. Pedagogies of engagement in the classroom incorporate student and faculty interactions that are related to positive academic development, personal development, and college satisfaction (Astin, 1993; Smith et al., 2015). Some examples of collaborative learning include working on group projects, think-pair-share activities, and group exams where students work together to complete the assessment. This communal atmosphere allows for opportunities for students to demonstrate mastery of knowledge. In fact, collaborative instruction and student engagement with peers and the instructor have been shown to improve student learning outcomes (Kuh et al., 2007; Pascarella & Terenzini, 2004; Smith et al., 2015). The ability to work in a community, rather than individually, to master difficult material allows students to acquire valuable skills needed during college and on the job market (Kuh et al., 2007)

Collaborative learning is rooted in Vygotsky's sociocultural theory, which affirms that learning is a social process (Dillenbourg, 1999). This social process is focused on how students use peer interaction to solve classroom problems (Nasir & Hand, 2006). Vygotsky's work also illuminates the importance of the zone of proximal development (Dillenbourg, 1999). The zone of proximal development (ZPD) can be defined as the academic level where students can understand a concept when working with others, but not individually (Kozulin, 2003). Working collaboratively with others gives students the opportunity to ask for help and for others to explain concepts to peers. Both contribute to students expanding their learning on class concepts (Nasir & Hand, 2006). In fact, Wenger (2000) hypothesizes that creating communities of practices where individuals can learn from one another creates strong avenues to master knowledge and cultivate a culture of collaboration. Not only does this framework prioritize learning, but collaborative learning also has the potential to yield positive non-academic psychosocial and motivational outcomes.

Literature Review: The need to address non-academic outcomes of student success

Given collaborative learning and how it builds upon sociocultural theory, this study seeks to contribute to the discussion surrounding the non-academic impacts of SCI. In particular, the study seeks to better understand the psychosocial and motivational perceptions of students in SCI courses when compared with students in didactic courses. Most previous work on STEM student success focuses on STEM academic performance rather than non-academic factors such as psychosocial and motivational factors that may contribute to the grades students receive in courses (Claesgens et al., 2008). However, previous work suggests that such non-academic factors may contribute to student future success that is not fully captured by immediate academic performance such as course grades (Ong et al., 2018; Pascarella & Terenzini, 2005). These include the psychosocial and motivational factors detailed below.

Psychosocial factors

Psychosocial factors are defined as the interaction of social, cultural, and environmental influences on mind and behavior (Guha, 2017). Due to the social and interactive nature of SCI, studies have shown impacts of the social context of the classroom contributing to the formation of relationships with other peers and with the instructor.

Relationship Building

Student-centered instruction (SCI) includes increased interactions with both their peers and faculty as compared to didactic instruction. Peer-to-peer interaction provides more opportunities for students to create relationships and maximize their learning (Deeter-Schmelz, et al., 2002; Johnson et al., 2013). Instructional strategies, such as group work and other collaborative learning activities, lead to greater peer social support both within and outside the classroom (Johnson et al., 2013). These supportive interpersonal relationships can increase course attendance, sense of belongingness into the university, and interest in the course curriculum (Kuh, 2007). Additionally, research has shown that group projects can enhance students' confidence by improving their self-esteem and sense of accomplishment. These results are due to group work allowing students to work together to solve complex problems and helps students develop interpersonal relationships, presentation skills, and leadership abilities – skills necessary for the job market. (Aggarwal & O'Brien 2008).

Faculty-student interactions are also important for student success. In a qualitative study of 210 students over 6 semesters, Hawk and Lyons (2008) found that conversations with faculty raised students' belief that they could be successful within a course. Faculty interactions that made students feel that faculty cared and believed in their academic ability led students to gain confidence in their academic skills (Hawk & Lyons, 2008). Faculty caring for students is an essential dimension to effective college teaching (Meyers, 2009). Professors showing concern for students while also being available to answer questions and encourage interaction not only positively impact students' attitudes toward the class, but also their academic behavior and how much they learn within the course (Meyers, 2009). Compared to lecturing, SCI gives students more opportunities to interact with faculty through diverse instructional practices.

Anxiety

Despite the positive results found surrounding peer and faculty interactions within the SCI classroom, mixed results have been found regarding how student-centered instruction relates to anxiety for students. These results are due to students having to speak and socially interact more in a course that uses SCI, particularly in large STEM courses, which may produce anxiety. High anxiety can lead to lower GPAs and lower academic performance (Vitasari et al., 2018). One study found that student-centered instruction may heighten anxiety due to its interactive nature and may be due to communication apprehension, social anxiety, and test anxiety (England et al., 2017). However, students reported that when instructors were caring and activities were highly structured, little anxiety occurred for student-centered courses (Cooper et al., 2018). Despite a discussion of anxiety and its impact on student success, few studies have assessed specific forms of anxiety, such as test anxiety, that may be impacted by student-centered instruction.

Motivational factors:

Previous research has examined how motivational factors, such as self-efficacy and task value, impact learning. Both
motivational outcomes derive in part from Expectancy Value Theory (Wigfield & Eccles, 2000). Expectancy Value Theory argues that student performance and persistence can be explained by whether students believe they can do well on a task and whether they see value in doing the activity (Wigfield & Eccles, 2000). Previous studies have also found that self-efficacy and task value can predict achievement (Hutchinson-Green et al., 2008).

Self-Efficacy

Self-efficacy is defined as a students' confidence that they can be successful in a specific course (Bandura, 1977). One study utilized SCI by employing inquiry-based labs where students were expected to collaborate to learn the material rather than the traditional "cookbook" lab where students follow steps with little critical thinking skills (Brownell et al., 2012). The study found that students had increased motivation and confidence in STEM courses, emphasizing how SCI courses can positively impact students' self-efficacy in a course (Brownell et al., 2012). Self-efficacy is also influenced by students' performance on various tasks, how much they contribute when working with peers, how well they know the material, and their grades (Hutchinson-Green et al., 2008). When traditional instruction takes place, students' self-efficacy is entirely dependent on grades due to a lack of other classroom experiences that could positively impact their self-efficacy.

Task Value

Task value can be defined as the perceived value a student has regarding a specific academic task (Harackiewicz et al., 2017). Multiple studies have been conducted to assess how increasing students' task value may improve their STEM interest and academic success within the course. For example, Hullemann and colleagues (2010) found that when creating classroom activities taking into consideration students' task value by discussing how activities can benefit them in the future increased student interest in the course and their intention to major in psychology. Not only is task value found to increase interest, but also to improve academic performances on exams, overall grade in the course, enrollment in the next course, and STEM major persistence (Canning et al., 2018). Studies have shown how vital task value is for student learning, but few have sought to understand how SCI may impact student task value.

Latine STEM Student Success and why it matters

Between 2000 and 2015, undergraduate enrollment at postsecondary institutions increased from 13.2 million to 17 million, with a projected increase to 19.3 million by 2026 (McFarland et al., 2017). This increase was not uniform across different student demographic groups. Between 2000 and 2015, Latine student enrollment more than doubled (a 126 percent increase from 1.4 million to 3.0 million students) and Black student enrollment increased by 73% from 1.5 million to 2.7 million students (McFarland et al., 2017). This influx of Latine and Black students have contributed to a more diverse higher education environment. Despite these increases, there is still a drastically low amount of STEM degree attainment. In 2018, Latine students only comprised 10% of STEM degrees (NSF, 2018). This translates later to a lower number of Latine people in the STEM workforce. Currently, the STEM workforce is only made of 7% Latine workers (Henningfield et al., 2021). Despite a Latine student increase in enrollment, their lower STEM persistence rate that results in lower STEM workforce rates requires further study, especially for those who are first-generation college students.

Due to the intersectionality of experiences, the need to focus on examining Latine, first-generation college students become apparent as they are both underrepresented in the higher education system and undergo other challenges being the first in their families to attend college (Stephens et al., 2012). Similar to ethnic minorities, first-generation college students are attending college at increasing rates: one out of every six four-year college students are a first-generation student (Saenz et al., 2007). Previous research has found universities individualistic and Eurocentric values result in minoritized students having to attempt to adjust to an environment not conducive to those with different values (McGee, 2020). These different norms contribute to first-generation college students experiencing culture shock which leads to more difficult adjustment periods (Phinney et al., 2003), with questions about whether they belong and can be successful (Johnson et al., 2013), and more frequent academic struggles and attrition (Pascarella et al., 2004).

Research Questions

To address the current gaps in the literature detailed above, this study aims to answer the following questions:

1. Compared to didactic instruction, and after controlling possible confounds, to what extent is student-centered instruction significantly and either positively or negatively associated with the following motivational and psychosocial outcomes?
    a) Relationship-building
    b) Test anxiety
    c) Self-efficacy
    d) Task value
2. Are any of these relationships between student-centered instruction and the motivational and psychosocial outcomes different for first-generation Latine students

Method

Study context

As identified in the literature review, research on instruction in Hispanic Serving Institutions (HSIs) is under researched. To aid in filling this necessary gap, this study was conducted at a university that was recently designated an HSI. The university is part of the University of California (UC) system, which is a network of research-focused public universities in California. In addition to being an HSI, this university recently built a facility that had only classrooms designed to support student-centered learning. Throughout the study, I will be calling the courses in this facility the student-centered building. In the student-centered building, each of the classrooms is intentionally built to make SCI more accessible with two different types of classrooms. The large lecture halls have chairs that swivel all the way around to promote more group work, and the student-centered classrooms have shared display monitors for students to work together on projects in the class. The classrooms also have whiteboards next to each table so students can work out problems together on the whiteboard and present their findings to the class. Instructors in the student-centered building who took part in a professional development series focused on making courses more active were given priority of the classrooms. However, not all courses within the building were designated as a SCI course. Traditional classrooms that do not have the architecture to support such instructional strategies as easily are also examined in this study and will be referred to as traditional classrooms in the rest of the document. Similarly, these courses in the traditional buildings could be designated either didactic or student-centered as well.

STEM courses in and out of the student-centered building were recruited to be observed and have students surveyed. To determine the impact of SCI on the above outcomes, we collected data to classify the type of instruction being used in the courses. Each course was classified as utilizing either student-centered or didactic instruction through the Classroom Observation Protocol for Undergraduate STEM (COPUS). The COPUS protocol is discussed more thoroughly in the data collection procedures section. Table 1.3 provides the number of student-centered and didactic instructed courses surveyed for 5 quarters and the demographics of the students.

Participants

STEM instructors were recruited prior to data collection to ask if they were interested in participating in the study. Overall, throughout 5 quarters of data collection, 58 STEM courses were surveyed. Each course had at least a 70% response rate with multiple courses having more than a 90% response rate.

Measures.

Relationship-building.

A 24-item scale was used from a previously validated study designed to measure the peer and instructor relationships created in the classroom. These questions were used to understand the social interactions and relationships students are building in the classroom. Three factors are measured in this scale, which include: student-student general relationships, student-instructor formal relationships, and student-instructor informal relationships. Answer choices were on a 5-point scale from 1 being "Strongly Disagree" to 5 being "Strongly Agree." Some of the statements include: "The students sitting near me rely on each other for help in learning class material" and "My instructor wants me to do well on the tests and assignments in this class." 3 outcomes were created from the scales and standardized for the regression analyses.

Test anxiety.

A three-item scale that measures students' anxiety when it comes to taking an exam was used and adapted from the Motivated Strategies Learning Questionnaire (MSLQ; Pintrich, 1991). These questions were used to determine how student-centered learning may impact anxiety in a course and have a 7-point scale with 1 being "Not at all true" to 7 being "Very True." An example of the statements is, "When I take a test, I think about items on other parts of the test I can't answer." A scale was created and standardized for the regression analyses.

Task value.

A 6-item scale from a previously validated survey was used and is intended to measure if students felt the course topics taught have value to their personal goals (Pintrich, 1991). Students were asked to rate each statement using a 7-point scale from 1 being “Not at all true” to 7 being “Very true." An example of the statements used is, "I think I will be able to use what I learn in this course in other courses." A scale was created and standardized for the regression analyses.

Self-efficacy.

The self-efficacy scale used is adapted from a previous scale intended to measure general self-efficacy (Sherer, 1982), but were adapted to measure students' self-efficacy in the context of the course. Two items were used for this study and were made into a binary outcome for the logistic regression.

Data collection procedures

Classroom Observation Protocol for Undergraduate STEM (COPUS).

The Classroom Observation Protocol for Undergraduate STEM (COPUS) was created using an evolutionary process over two years and nine different iterations of the protocol were created before the one used for this study was finalized (Smith et al., 2013). Trained observers coded from a list of actions that the instructor and students were doing every two minutes. In addition to the options given, observers also could use an "Other" option that required an explanation if none of the given options applied. Table 1.1 provides the codes used in the COPUS observation protocol. There are a total of 13 student and 12 instructor behaviors that can be documented. Two classes per course were observed randomly per quarter to classify the type of instruction being used in the course. Courses were observed randomly to avoid instructors preparing for observers and changing their normal instruction style.

After the COPUS data were collected, a cluster analysis was conducted to better categorize the type of instruction into a single classification. Methodology from previous research was taken into consideration to determine the most appropriate method to cluster the data (Denaro et al., 2021; Stains et al., 2018). A k-means cluster analysis, which is a data reduction method, was used to categorize the COPUS data. Two types of clusters were created and can be labeled as "interactive, or SCI" or "didactic," which means more passive instructional strategies were used.

Student survey collection.

Student surveys were collected between weeks 8 and 9 of each quarter for 57 courses during data collection. The measures described above were used in the survey with minor revisions made to improve the fit of the survey measurements for this population. To test survey items before distribution, a pilot survey was given to students to ask about questions used in the survey, in order to time how long it took students to complete the survey and receive feedback from students on which items may be unclear. The survey took students on average 10-15 minutes to complete and had a response rate of 70% in most courses. After data was collected, institutional demographic information was pulled for each course. This data included students' ethnicity, first-generation status, income level, as well as prior academic achievements such as SAT scores and GPA.

Data Analysis Methods

In order to compare psychosocial and motivational outcomes for students in SCI courses with didactic courses, an Ordinary Least Squares (OLS) regression model will be used. The key variable of interest for this analysis considers if COPUS observations indicate that the course implements more interactive, student-centered teaching methods (i.e., group work). Below is the regression equation used:

$$Y=\beta_0 + \beta_1(\text{Student-Centered Instruction}) + \beta_2(\text{Student Level Covars}) + \beta_3(\text{Instructor Covars})+ \beta_4(\text{Course Covars})+ \alpha+ e$$

Y is each of the four outcomes of relationship building, test anxiety, task value and self-efficacy. β_1 is if the course is considered to use student-centered teaching methods which is determined by the COPUS data regardless of building type. β_2 is the student-level covariates which will be used as controls. These include prior overall GPA, SAT scores, gender, student race/ethnicity, first-generation college student, low-income student, major, and year in school. These are included as demographics to account for students' individual differences that may be related to their survey responses. To account for instructor differences, β_3 is the instructor level covariates which include gender and if they are research or teaching faculty. β_4 are variables that control for course-level covariates which include the enrollment for the course, class composition measures, and discipline. This course variates are included to take into account different class sizes, discipline cultures, and the demographics of a course that may be related to survey responses. Additionally, α denotes that term fixed effects meant to take into account time-invariant differences occurring during different quarters.

To understand to what extent, the psychosocial and motivational factors may differentially be associated with Latine, first-generation college students, two interaction variables were included in the above regression model. The equation is the following:

$Y=\beta_0 + \beta_1$(Student-Centered Instruction) + β_2(Student Level Covars) + β_3(Instructor Covars)+ β_4(Course Covars)+ β_5(Latine*Student-Centered Instruction)+ β_6(Latine*Percentage of Latine Students in Course)+α+ e

Latine*Student-centered is intended to measure to what extent does being Latine and in a SCI course differentially related to the psychosocial and motivational outcomes. Number of Latine students*Student-centered in the course is intended to measure to what extent does the number of Latine being in a student-centered course may be related to the psychosocial and motivational outcomes.

Outcome Variables

Three out of four outcome variables include standardized scaled scores from the following measures: relationship building, test anxiety, and task value. More details for the measures are in the above section. For each scale, a CFA was conducted to check for the goodness of fit with the data. The CFI, RMSEA, and SRMR were all in acceptable ranges. Table 1.2 gives a description of each outcome. A scaled score was then created using the items from each measure. For the self-efficacy outcome, due to the poor fit of the scale with the data, two items were pulled and used as outcome variables for a logistic regression. To make a binary outcome, if students reported a “Strongly Agree” or “Agree” for the two questions, it was coded as a 1, all other responses were coded as a 0.

Results

Table 1.3 provides descriptive information for the students that were surveyed in this study. The table provides demographic information for the entire sample and for both the SCI and didactic classes. The table provides percentages of students from different ethnicities and departments as well as the average SAT score and the percentage of first-generation college students. In total, 57 courses were surveyed—28 SCI courses and 29 traditional courses. Some of the differences between the type of courses include more low-income students are present in the SCI course (34% in the SCI courses and 31% in the didactic courses). Additionally, there were higher average SAT courses and cumulative GPA in the didactic courses. Another difference is 45% of students in the SCI courses were enrolled in biological sciences courses whereas 22% of students in the didactic courses were in a biological science course. This is the biggest difference between the two clusters.

Research Question 1. Compared to didactic instruction, to what extent does student-centered instruction impact the described psychosocial and motivational outcomes?

Psychosocial outcomes

Relationship-building

Table 1.4 displays the regression analyses for the relationship building outcomes of peer relationships, formal interaction with instructions, informal interactions with instructors and our test-anxiety scale. Term-level fixed effects, student demographics, instructor demographics, course composition, and discipline are all taken into consideration for the regression models. Overall, being in a student-centered course, is associated with significantly higher peer relationships (0.24 standard deviation units) when controlling for all the above characteristics. The regression model also considered the student-centered building and found being in the building is associated with higher peer relationship scores and more interactions with the instructor (0.193 and 0.137 standard deviation units, respectively).

Additionally, there were findings present in the data that future studies may find interesting to investigate. These include that taking a course with a teaching faculty member, as opposed to a research faculty, is related to higher interactions with the instructor (.118 standard deviation units). Discipline also had some significant associations. When compared to the biological sciences, the physical sciences and computer sciences were associated with significantly lower peer relationships (-0.222 and -0.306 standard deviation units, respectively) and informal instruction interactions (physical sciences: -0.112 standard deviation units). Finally, being Latine and the higher Latine enrollment in a course is related to higher feelings of the instructor caring (0.041 and 0.035 standard deviation units, respectively) while being Latine is related to lower formal interactions with the instructor when compared to White students (-0.145 standard deviation units). This will be investigated more in the upcoming analyses.

Test Anxiety

Despite encouraging results surrounding relationship-building, Table 1.4 also shows some discouraging results regarding test anxiety. Students in an SCI course are associated with significantly higher reports of test anxiety (0.217 standard deviation units). However, those in the student-centered building were associated with lower levels of test anxiety (-0.226 standard deviation units), suggesting the importance of a conducive environment for SCI. Additionally, having a teaching instructor was related to lower test anxiety (-.163 standard deviation units) than courses taught by research professors.

Motivational Outcomes

Task Value

Table 1.5 provides the results for the motivational outcomes of task value and self-efficacy. For task value, which is that students feel what they are learning is meaningful for their future goals (Hulleman et al., 2010), we saw no significance for being in a SCI course and task value. However, there was a significant positive relationship between taking courses in the student-centered building rather than traditionally structured facilities (.107 standard deviation units).

Self-Efficacy

Self-efficacy results in Table 1.5 are reported in odds ratios due to a logistic regression used for the two binary outcomes. One finding is that students in SCI courses have higher odds of trying harder when doing poorly, with an increase of 46% when controlling for student, instructor, and course covariates. Additionally, being in the student-centered building is related to 63% greater odds of feeling you can meet the academic challenges of the course. Additional findings suggest odds of having lower self-efficacy for women is significant. This finding is like other studies that have found similar results (Ellis et al., 2016). Moreover, courses with a greater proportion of women in the class are associated with 57% higher odds of feeling like the student can meet the academic challenges of the course.

Research Question 2: Are any of these relationships between student-centered instruction and the motivational and psychosocial outcomes different for first-generation and Latine students? In particular, is student-centered instruction particularly helpful for these students?

Psychosocial

Table 1.6 displays the results for the regression with the two interactions of being Latine and in a student-centered course and the number of Latine students and being in a SCI course.

For the relationship-building scales, the interactions were not significant. However, when including the interactions, peer relationships lower slightly but still remains highly significant. When in a student-centered course, students report 0.233 standardized units higher peer relationship building than students in a traditional course. For both instructor formal and informal interactions, there were little differences present. However, when including the two interactions, being Latine was related to 0.047 standard deviation units more informal instructor interactions and -0.111 standard deviation unit less formal instructor interactions. Additionally, the results from the number of Latine students in a course decreased when added interactions, however it remained significant. The more Latine students in a course was related to students reporting 0.033 standard deviation units more instructor informal interactions.

For the test anxiety outcome, the number of Latine students in a SCI course was statistically significant at -0.055 standard deviation units. This signifies that the more Latine students in a course and being in a SCI course lowers test anxiety by -0.055 standard deviation units, resulting in the main effect coefficient becoming 0.135 standard deviation units rather than 0.190 units. Despite the interaction, being in a SCI course was still related to higher test anxiety.

Motivational

Table 1.7 represents the results of the task value and self-efficacy outcomes when the two interaction variables were included in the model. For the task-value outcome, being a student-centered classroom, being Latine, and the number of Latine students in a course remained insignificant. However, when adding the interactions, the odds of trying harder when doing poorly in a student-centered course rose from 46% to 50%.

Discussion

This study demonstrates four key components that contribute to a positive learning environment for students. One main component is that student-centered instruction results in more opportunities to build peer relationships. Other key components include the physical environment, taking a course with a teaching faculty member, and the diversity of the course.

Student-centered instruction encourages peer relationship-building

Overall, this study exemplifies a relationship between being in SCI courses and more peer and faculty interaction. This finding aligns with pedagogies of engagement and collaborative learning frameworks, which highlight that interactive teaching methods can support collaboration and relationship building. Peer interactions were found to be most present in SCI courses, which suggests that being in SCI courses has the potential to increase the number of opportunities to build peer relationships. Given that previous studies have found numerous benefits of peer relationships—including increased STEM persistence (Dennis et al., 2005)—these findings suggest that SCI classrooms show promise for increased student success.

Learning environments matter: Physical environment, teaching faculty, and diversity of the course

This study also found that the learning environment plays a big role in students' psychosocial and motivational outcomes. Being in the student-centered building was associated with higher peer interaction, more formal instructor interactions, higher task value, and higher self-efficacy. As this building was created to make SCI courses easier to facilitate, these findings are encouraging. They also align with Strange and Banning's work which found that well-designed university buildings have a positive impact on student engagement, learning, and feelings of support and belonging (2001).

In addition to physical space, teaching faculty were found to create learning environments that were related to more instructor interactions and lower test anxiety. Previous research has shown that teaching faculty have pedagogical training and expertise while many teaching faculty are also involved in the scholarship of teaching and learning (SOTL) research (Harlow et al., 2020 & Bush et al., 2011). The instruction expertise and knowledge of evidence-based teaching practices could contribute to higher quality instruction, student engagement, and designing courses where learning environments promote instructor interaction and less anxiety surrounding exams.

The diversity of the learning environment mattered as well. A greater number of females in a course was related to higher odds of having stronger self-efficacy perceptions. This relationship with course composition also rang true for Latine students. A greater number of Latine students in a course was related to more informal interactions with faculty. Furthermore, the combination of being in a SCI course with having a greater number of Latine students significantly related to lower test anxiety. These findings suggest that greater diversity may impact student's perceptions of instructor interactions, test anxiety and self-efficacy—resulting in learning environments that improve students' psychosocial and motivational outcomes. This is encouraging as the more diverse a classroom, the less isolated marginalized students might feel and are better able to create a sense of community and support in the classroom (Schlossberg, 1989)

Study limitations and future directions

One limitation of the study is the overrepresentation of biological sciences courses present in the data. In the SCI cluster, 45% of students surveyed were in biological sciences while only 22% of students were in the didactic cluster. This may have skewed the results surrounding STEM department coefficients. Additionally, another limitation in this study is the non-causal relationships. As this study is purely descriptive, it can open the door and provide ideas for future studies to estimate causal relationships between SCI courses and non-academic outcomes.

Future directions for possible studies include focusing on STEM discipline differences and the relationship between SCI courses and non-academic outcomes. As each STEM discipline is unique, better understanding specific STEM disciplines and students' perceptions of SCI could be particularly meaningful. Another future direction is focusing on learning environments and how they are related to student perceptions. For example, examining the student-centered building and its relationship with academic disparities within a course.

Conclusion

Overall, this study intended to explore the relationship between student-centered instruction and non-academic outcomes such as those that are psychosocial and motivational. Encouragingly, this study found being in a SCI course was significantly related to more peer-relationship building, which improves peer support networks and contributes students to building a support system to help navigate their STEM discipline. Additionally, this study found that the components of a course that includes physical environment, teaching faculty, and the diversity in a course all contribute to positive learning environments for students, especially those that are minoritized.

Table 1.1 COPUS categories

Instructor Codes	Definition	Student Codes	Definition
Instructor.Lec	Lecturing (presenting content, deriving mathematical results, presenting problem solution, etc.)	Student.L	Listening to instructor/taking notes, etc.
Instructor.RtW	Real-time writing on board, document projector, etc. (often checked off along with Lec)	Student.Ind	Individual thinking/problem solving. Only mark when an instructor explicitly asks students to think about a clicker question or another question/problem on their own.
Instructor.FUp	Follow-up/feedback on clicker question or activity to entire class	Student.CG	Discuss clicker question in groups of 2 or more students
Instructor.PQ	Posing non-clicker question to students (non-rhetorical)	Student.WG	Working in groups on worksheet activity
Instructor.CQ	Asking a clicker question (mark the entire time the instructor is using a clicker question not just when first asked)	Student.OG	Other assigned group activity, such as responding to instructor question
Instructor.AnQ	Listening to answering student questions with entire class listening	Student.AnQ	Student answering a question posed by the instructor with rest of class listening
Instructor.MG	Moving through class guiding ongoing student work during active learning task	Student.SQ	Student asks question

Instructor.1o1	One-on one extended discussion with one or a few indivduals, not paying attention to the rest of the class (can be along with MG or AnQ)	Student.WC	Engaged in whole class discussion by offering explanations, opinion, judgement, etc. to whole class, often facilitated by instructor
Instructor.DV	Showing or conducting a demo, experiment, simulation, video, or animation	Student.Prd	Making a predication about the outcome of demo or experiment
Instructor.Adm	Administration (assign homework, return tests, etc.)	Student.SP	Presentation by student(s)
Instructor.W	Waiting when there is an oportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor is not doing so	Student.TQ	Test or quiz
Instructor.Other	Other-explain in comments	Student.W	Waiting (instructor late, working on fixing AV problems, instructor otherwise occupied, etc.)
		Student.Other	Other-explain in comments

Table 1.2 Outcome Measures

	Relationship-Building	Test Anxiety	Task Value	Self Efficacy
Psychosocial or Motivational?	Psychosocial	Psychosocial	Motivational	Motivational
Definition	Measure the peer and instructor relationships built inside the classroom. Three factors are being measured in this scale, which include: student-student general relationships, student-instructor formal relationships, and student-instructor informal relationships	Measures students' anxiety relating to taking an exam.	Measures if students felt the course topics taught have value to their personal goals.	Adapted to measure students' feelings they can be academically successful in the course.
Numbers of Items	24	3	6	2
Scale	5-point scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree")	7-point scale with 1 being ("Not at all true") to 7 being ("Very True")	5-point scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree")	5-point scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree")
Example of statements in scale	"The students sitting near me rely on each other for help in learning class material." "My instructor wants me to do well on the tests and assignments in this class."	"When I take a test, I think about items on other parts of the test I can't answer."	"I think I will be able to use what I learn in this course in other courses."	“I am able to meet the academic challenges of this course.” “Doing poorly in this course just makes me want to try harder.”

Citation Scale	Walker, J. D., & Baepler, P. (2017). Measuring Social Relations in New Classroom Spaces: Development and Validation of the Social Context and Learning Environments (SCALE) Survey. Journal of learning spaces, 6(3), 34-41.	Pintrich, P. R. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ).	Pintrich, P. R. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ).	Sherer, M., Maddux, J. E., Mercandante, B., Prentice-Dunn, S., Jacobs, B., & Rogers, R. W. (1982). The self-efficacy scale: Construction and validation. Psychological reports, 51(2), 663-671.

Table 1.3 Demographic information of sample

	Total				Student-Centered				Didactic			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
East Asian	25%	0.43	0	1	23%	0.42	0	1	26%	0.44	0	1
Black	3%	0.17	0	1	3%	0.16	0	1	3%	0.17	0	1
Native	<1%	0.04	0	1	<1%	0.04	0	1	<1%	0.04	0	1
White	14%	0.34	0	1	14%	0.35	0	1	13%	0.34	0	1
Indian	6%	0.23	0	1	5%	0.22	0	1	6%	0.24	0	1
First Generation	45%	0.50	0	1	46%	0.50	0	1	45%	0.50	0	1
Low Income	32%	0.47	0	1	34%	0.47	0	1	31%	0.46	0	1
SAT Math	638.62	89.97	200	800	629.90	90.98	340	800	644.40	88.84	200	800
SAT Read	592.17	91.31	200	800	586.70	90.35	300	800	595.80	91.76	200	800
SAT Writing	587.31	84.37	230	800	582.61	84.89	320	800	590.42	83.88	230	800
Cumulative GPA	3.20	0.52	0	4	3.19	0.56	0	4	3.20	0.49	1	4
Course-Level Covariates												
Discipline												
Biological Sciences	31%	0.46	0	1	45%	0.50	0	1	22%	0.42	0	1
Engineering	3%	0.17	0	1	1%	0.09	0	1	4%	0.20	0	1

Computer Science and Informatics	21%	0.40	0	1	15%	0.36	0	1	24%	0.43	0	1
Physical Sciences	33%	0.47	0	1	29%	0.45	0	1	36%	0.48	0	1
Instructor												
Female Instructor	62%	0.49	0	1	76%	0.42	0	1	61%	0.49	0	1
Teaching Instructor	81%	0.39	0	1	86%	0.34	0	1	77%	0.42	0	1
Number of courses	57				28				29			

Table 1.4. Relationship of Student-Centered Courses on Psychosocial Outcomes

	Relationship-Building			Test Anxiety
	Peer-Peer Relationship	Student-Instructor Informal Interaction	Student-Instruction Formal Interaction	
Student-Centered Course	0.240***	0.039	0.088	0.217*
	(0.06)	(0.03)	(0.06)	(0.09)
Student-Centered Building	0.193**	0.064	0.137**	-0.226**
	(0.07)	(0.04)	(0.04)	(0.08)
Student				
Latine	-0.022	0.041*	-0.114***	-0.061
	(0.03)	(0.02)	(0.02)	(0.06)
Black	-0.035	0.058	0.033	-0.020
	(0.06)	(0.03)	(0.06)	(0.12)
Southeast Asian	0.008	0.028	-0.135***	0.157*
	(0.03)	(0.01)	(0.03)	(0.06)
Female	0.062*	-0.010	-0.145***	0.058
	(0.03)	(0.01)	(0.02)	(0.04)
Low-Income	-0.069**	-0.010	0.002	-0.017
	(0.02)	(0.01)	(0.02)	(0.08)

First Generation College Student	0.009	0.017	-0.027	0.056
	(0.02)	(0.01)	(0.02)	(0.05)
SAT Math	-0.047**	-0.002	0.009	-0.136***
	(0.02)	(0.01)	(0.01)	(0.03)
Cumulative GPA	0.090***	0.021**	0.004	-0.211***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor				
Female Instructor	-0.028	-0.026	-0.040	0.058
	(0.06)	(0.03)	(0.05)	(0.08)
Teaching Instructor	-0.001	0.016	0.118*	-0.163*
	(0.13)	(0.03)	(0.05)	(0.06)
Discipline				
Physical Sciences	-0.222**	-0.112**	-0.062	-0.337**
	(0.07)	(0.04)	(0.05)	(0.11)
Engineering	0.097	0.026	-0.010	-0.347**
	(0.12)	(0.03)	(0.11)	(0.12)
Computer Science/Informatics	-0.306**	-0.060	-0.111	-0.938***
	(0.11)	(0.05)	(0.09)	(0.18)
Course Composition				
Course Enrollment	-0.153**	0.037	-0.190***	0.449***

	(0.06)	(0.03)	(0.05)	(0.11)
Number of Female Students	0.026	-0.008	-0.025	-0.399***
	(0.03)	(0.01)	(0.03)	(0.08)
Number of Latine Students	-0.038	0.035**	0.034	0.035
	(0.03)	(0.01)	(0.02)	(0.05)
N	8154	8097	8097	2191

Note. All continuous variables are standardized. *p<.01 **p<.002 ***p<.0001

Table 1.5 Relationship of Student-Centered Courses on Motivational Outcomes

	Task Value	Self-Efficacy	
		Able to meet academic challenges	Doing poorly just makes me try harder
Student-Centered Course	-0.064	1.210	1.464*
	(0.06)	(0.276)	(0.264)
Student-Centered Building	0.107*	1.631*	1.161
	(0.05)	(0.345)	(0.200)
Student			
Latine	0.028	0.995	1.015
	(0.02)	(0.163)	(0.137)
Black	-0.011	0.696	0.711
	(0.03)	(0.205)	(0.188)
Southeast Asian	0.001	0.769	1.116
	(0.02)	(0.104)	(0.127)
Female	0.010	0.753*	0.809*
	(0.01)	(0.088)	(0.076)
Low-Income	0.004	0.957	1.128
	(0.01)	(0.121)	(0.119)

First Generation College Student	0.003	1.097	1.049
	(0.02)	(0.140)	(0.109)
SAT Math	-0.016	1.073	0.897
	(0.01)	(0.075)	(0.052)
Cumulative GPA	0.020	1.595***	1.152**
	(0.01)	(0.094)	(0.057)
Instructor			
Female Instructor	-0.096*	0.577***	0.955
	(0.04)	(0.095)	(0.119)
Teaching Instructor	0.016	0.629*	1.014
	(0.07)	(0.119)	(0.145)
Discipline			
Physical Sciences	-0.044	1.750	1.039
	(0.05)	(0.581)	(0.278)
Engineering	-0.054	2.916*	0.853
	(0.06)	(1.341)	(0.275)
Computer Science/Informatics	-0.020	3.973***	0.765
	(0.07)	(1.640)	(0.236)
Course Composition			
Course Enrollment	-0.073	0.440***	0.975

	(0.05)	(0.091)	(0.149)
Number of Female Students	0.007	1.578*	0.930
	(0.02)	(0.327)	(0.145)
Number of Latine Students	0.005	1.074	1.028
	(0.02)	(0.136)	(0.103)
N	8097	2332	2332

Note. Self-efficacy coefficients are reported in odds ratios. *All continuous variables are standardized. *p<.01 **p<.002 ***p<.0001*

Table 1.6 Relationship of Student-Centered Courses on Psychosocial Outcomes with Interactions

	Relationship-Building			Test Anxiety
	Peer-Peer Relationship	Student-Instructor Informal Interaction	Student-Instruction Formal Interaction	
Student-Centered Course	0.233***	0.045	0.092	0.190*
	(0.06)	(0.03)	(0.06)	(0.08)
Student_Centered Building	0.192**	0.064	0.138**	-0.179*
	(0.07)	(0.04)	(0.04)	(0.06)
Interactions				
Latine*Student-Centered	0.038	-0.031	-0.017	0.011
	(0.06)	(0.02)	(0.05)	(0.10)
Number of Latine in a Course*Student-Centered	0.005	0.012	0.024	-0.055*
	(0.04)	(0.02)	(0.05)	(0.03)
Student				
Latine	-0.031	0.047*	-0.111***	-0.058
	(0.04)	(0.02)	(0.03)	(0.07)
Black	-0.034	0.058	0.033	-0.026
	(0.06)	(0.03)	(0.06)	(0.12)

Southeast Asian	0.009	0.028	-0.136***	0.152*
	(0.03)	(0.01)	(0.03)	(0.06)
Female	0.062*	-0.010	-0.145***	0.059
	(0.03)	(0.01)	(0.02)	(0.04)
Low-Income	-0.069**	-0.009	0.002	-0.014
	(0.02)	(0.01)	(0.02)	(0.08)
First Generation College Student	0.007	0.020	-0.025	0.060
	(0.02)	(0.01)	(0.02)	(0.04)
SAT Math	-0.048**	-0.002	0.009	-0.135***
	(0.02)	(0.01)	(0.01)	(0.03)
Cumulative GPA	0.091***	0.021*	0.003	-0.213***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor				
Female Instructor	-0.029	-0.026	-0.040	0.081
	(0.06)	(0.03)	(0.05)	(0.08)
Teaching Instructor	-0.003	0.016	0.117*	-0.136
	(0.13)	(0.03)	(0.05)	(0.07)
Discipline				
Physical Sciences	-0.222**	-0.112**	-0.062	-0.356**
	(0.07)	(0.04)	(0.05)	(0.11)

Engineering	0.097	0.026	-0.009	-0.348**
	(0.12)	(0.03)	(0.11)	(0.10)
Computer Science/Informatics	-0.308**	-0.061	-0.114	-0.927***
	(0.11)	(0.05)	(0.09)	(0.17)
Course Composition				
Course Enrollment	-0.154**	0.037	-0.190***	0.472***
	(0.06)	(0.03)	(0.05)	(0.12)
Number of Female Students	0.025	-0.008	-0.025	-0.390***
	(0.03)	(0.01)	(0.03)	(0.07)
Number of Latine Students	-0.040	0.033*	0.030	0.051
	(0.03)	(0.01)	(0.02)	(0.05)
N	8154	8097	8097	2191

Note. All continuous variables are standardized. *p<.01 **p<.002 ***p<.0001.

Table 1.7 Relationship of Student-Centered Courses on Motivational Outcomes with Interactions

	Task Value	Self-Efficacy	
		Able to meet academic challenges	Doing poorly just makes me try harder
Student-Centered Course	-0.059	1.195	1.502*
	(0.06)	(0.285)	(0.283)
Student-Centered Building	0.107*	1.535	1.108
	(0.05)	(0.348)	(0.205)
Interactions			
Latine*Student-Centered	-0.025	1.329	1.012
	(0.03)	(0.355)	(0.225)
Latine*Number of Latine in a Course	0.027	1.038	1.053
	(0.03)	(0.101)	(0.087)
Student			
Latine	0.033	0.904	1.006
	(0.02)	(0.165)	(0.154)
Black	-0.011	0.711	0.716
	(0.03)	(0.210)	(0.190)
Southeast Asian	0.001	0.779	1.121

	(0.02)	(0.106)	(0.127)
Female	0.010	0.752*	0.808*
	(0.01)	(0.088)	(0.076)
Low-Income	0.004	0.954	1.124
	(0.01)	(0.121)	(0.119)
First Generation College Student	0.006	1.069	1.046
	(0.02)	(0.138)	(0.110)
SAT Math	-0.016	1.073	0.896
	(0.01)	(0.075)	(0.052)
Cumulative GPA	0.019	1.609***	1.155**
	(0.01)	(0.096)	(0.058)
Instructor			
Female Instructor	-0.096*	0.553***	0.933
	(0.04)	(0.095)	(0.121)
Teaching Instructor	0.015	0.599**	0.986
	(0.07)	(0.116)	(0.147)
Discipline			
Physical Sciences	-0.044	1.824	1.059
	(0.05)	(0.610)	(0.285)
Engineering	-0.052	2.895*	0.853

	(0.06)	(1.332)	(0.275)
Computer Science/Informatics	-0.023	3.920***	0.755
	(0.07)	(1.621)	(0.233)
Course Composition			
Course Enrollment	-0.073	0.422***	0.955
	(0.05)	(0.090)	(0.149)
Number of Female Students	0.008	1.552*	0.920
	(0.02)	(0.323)	(0.144)
Number of Latine Students	-0.000	1.065	1.015
	(0.02)	(0.138)	(0.104)
N	8097	2332	2332

Note. Self-efficacy coefficients are reported in odds ratios. All continuous variables are standardized. *p<.01 **p<.002 ***p<.0001

CHAPTER 3: STUDY 2—Exploring the academic outcome relationship between student-centered instruction and physical space designed for student-centered learning

Over the past decade, there have been growing concerns regarding the quality of undergraduate education across the country (Woodin et al., 2017). Students who begin in STEM majors are leaving the major or dropping out of universities altogether at higher rates than students who begin in a non-STEM discipline (Kuenzi et al., 2006). A contributing factor to these poor outcomes is the traditional classroom structure in which instructors overwhelmingly lecture with minimal student interaction (Kokkelenberg et al, 2010; Bransford et al., 2000). Previous research has proposed possible solutions to enhance classroom engagement in STEM undergraduate classrooms, including high structure courses that leverage student interaction and higher order cognitive skill development (Haak et al., 2011; Theobald et al., 2020). Furthermore, student-centered instruction (SCI) has been found to close learning gaps and improve self-efficacy and belonging for minoritized students (Ballen et. al, 2017). SCI can be defined as teaching practices focused on student interaction and engagement with the material and is often collaborative in nature. Unfortunately, there are barriers to implementation of SCI, particularly in research-intensive institutions, including lack of faculty incentive to modify one's teaching, increasing STEM course enrollments, and logistical issues related to teaching in the traditional large lecture hall (Cotner et al., 2013; Falkenheim et al., 2015). Universities are spending resources to create classroom spaces that encourage and support SCI, with the goal to alter instructor teaching practices and student outcomes (Ellis et al., 2016). In this study, I aim to examine the impact of a building designed for SCI and SCI overall on student outcomes.

Theoretical Framework—Pedagogy-space-technology framework

A nascent field of study has begun to gain traction that focuses on how the physical features of learning spaces may contribute to the successful implementation of learning activities to enhance student engagement and learning (Ellis et al., 2016). Currently, there are calls for action to empirically explore how physical learning space is related to student learning (Temple, 2014). This is occurring during a period in higher education where online learning has risen in popularity resulting some to question the value of a physical university campus and learning environment (Breslow et al., 2013; Gasevic et al., 2014). However, previous research highlights the benefits of SCI and student interaction within the same physical space (Bereiter, 2002). However, SCI pedagogies are difficult to implement in traditional learning spaces (Ellis et al., 2016). This has resulted in a debate on the need for physical learning environments to change from traditional, lecture-based halls to spaces more conducive to SCI practices (Schratzenstaller, 2010). Learning spaces that seat students in pods or groups rather than in a theater-style room have been shown to promote SCI activities (Ellis et al., 2016).

Radcliffe (2009) suggests a model that contributes to the discussion of how space informs pedagogy by suggesting the need to consider the relationship between pedagogy, physical space, and technology when creating conducive places for student learning. The model details how pedagogy-space-technology framework includes how space encourages pedagogy, while pedagogy is also enabled by space (Radcliffe, 2009). This model suggests the importance of space for instruction.

Limited research has identified that spaces that allow for student interaction have been found to have a positive impact on student engagement, learning, and feelings of support and belonging (Strange & Banning, 2001). For example, Ogilvie and colleagues found that when large lecture halls incorporated swivel chairs to promote group discussions, students in the swivel chair lecture hall versus the traditional lecture hall scored higher on the final exam for the course (Ogilvie, 2008). However, the value of physical space in higher education is under-researched, despite the amount of money spent on infrastructure and maintenance each year (Strange & Banning, 2001). Furthermore, physical space has been claimed to be the least understood topic that impacts student learning (Strange & Banning, 2001).

This study uses courses in a recently opened multi-million dollar building that only has classrooms made to support SCI. Throughout the study, I will be calling the facility the student-centered building (SCB). In the SCB, each of the classrooms is intentionally built to make SCI more accessible with two types of classroom spaces. The first type of classroom is a large lecture hall with chairs the swivel around while the second type of classroom has tables in pods to encourage collaboration. Present in the study is also traditional classrooms that do not have the architecture to support such instructional strategies as easily. This study will focus on how the physical building and its interaction with teaching methods impacts students' academic performance.

Literature Review

SCI as a means to enhance student academic success

Previous research has suggested that student-centered instruction (SCI) allows for an increase in student learning (Pascarella et al., 2004) which has been suggested to be particularly true for first-generation and minoritized college students (Eddy & Hogan, 2014; Haak et al., 2011; Harackiewcz et al., 2016). These positive findings may be due to SCI giving students unique opportunities not often evident in a traditional lecture course. For example, in a SCI course, students have multiple avenues to learn the material including textbook readings, instructor lectures, group discussions with peers, and classroom response devices such as iClickers. This differs from solely having to acquire knowledge through passively listening to an instructor lecture in a didactically structured course. Besides increased engagement, extensive literature also finds relationships between SCI teaching methods and student motivation, academic performance, and retention in the STEM major (Michael, 2006).

Research has also shown the benefits of structured group work, a component often found in many SCI courses. For example, group work gives students the experience of obtaining "real world" skills due to collaborative problem-solving activities with peers (Aggarwal & O'Brien, 2008). These group work activities also provide opportunities for students to think critically and answer questions from peers (Aggarwal & O'Brien, 2008). Group work has also been found to lead to an increase in student retention due to the creation of social networks (Treisman, 1985; Wales & Sager, 1978).

Previous research has also directly compared courses that employ traditional instructional methods with courses that are student-centered to explore the relationship between SCI and academic performance. For example, Deslauriers and colleagues (2011) compared the learning in one course traditionally instructed with an experienced and well-liked instructor and one that was taught by an inexperienced instructor who used student-centered instructional strategies such as constant peer interaction while also practicing critical reasoning and problem-solving skills. Despite having an inexperienced instructor, the study found an increase in student attendance, more engagement, and students performed twice as well on the exam in the student-centered course (Deslauriers et al., 2011). Additional research has found that average scores on exams improved 6% over that of the traditional class, where students were 1.5 times more likely to fail the course and that more interactive learning strategies improved academic outcomes across class sizes (Freeman et al., 2014).

Differential impacts for minority and first-generation college students

Previous research has also suggested that first-generation students of color benefit more from STEM SCI courses than traditional students. In a double-blind, randomized experiment implementing SCI strategies that focused on increasing task value, researchers found that first-generation college students of color had an increase in interest in biology while also reducing the final course grade differences in the class by 61% (Harackiewcz et al., 2016). Increased course performance was a focus in other studies as well. One found that including SCI teaching methods increased course performance for all students, but disproportionately increased achievement for first-generation Black college students (Eddy & Hogan, 2014). Haak and colleagues found that implementing daily and weekly practice problems, activities that require data analysis, and other activities that use higher-order cognitive thinking skills, decreased achievement gaps without having to increase expenditures from the university to improve student success (Haak et al., 2011). These findings are particularly relevant as some claim the only way to improve achievement for first-generation students of color is through increased funding to support programs. Despite positive findings of SCI and its relationship with first-generation students of color, few studies have focused on first-generation, Latine college students as a distinct group.

The need to focus on Latine, first-generation college students

In 2015, Latine college enrollment more than doubled (a 126 percent increase from 1.4 million to 3.0 million students) within a 15 year period (McFarland et al., 2017). This influx of Latine students has contributed to a more diverse higher education environment. STEM degree attainment for Latine students is still drastically lower despite these enrollment increases. In 2018, Latine students only comprised 10% of STEM degrees (NSF, 2018) which then translates to a lower number of Latine people in the STEM workforce. Currently, the STEM workforce is only made of 7% Latine workers (Henningfield et al., 2021). Despite a Latine student enrollment increase, their lower STEM persistence rate requires further study, especially for those who are first-generation college students.

Due to the intersectionality of experiences, the need to focus on examining Latine, first-generation college students become apparent in light of the underrepresentation of both of these groups in higher education (Stephens et al., 2012). Previous research has found universities individualistic and Eurocentric values result in minoritized students having to attempt to adjust to an environment not conducive to their values, including building community and collaboration (McGee, 2020). These different norms contribute to first-generation and Latine college students experiencing culture shock which leads to more difficult adjustment periods (Phinney et al., 2003) that create questions about whether they belong and can be successful (Johnson, et al., 2011), and more frequent academic struggles and attrition (Pascarella et al., 2004). As both SCI and designed for SCI classroom spaces have been shown to benefit student learning, this study seeks to examine the academic outcomes of Latine and first-generation college students in both traditional and student-centered classrooms.

Research Question

1. Do student-centered classrooms increase the academic performance of Latine students compared to other race/ethnic groups?

2. Do student-centered classrooms increase the academic performance of underrepresented racially minoritized students?
3. Are there differences in academic outcomes when comparing student-centered courses and didactic courses within and not within the student-centered building?

Method

Study Context

The study is being conducted at a research-intensive university that was designated as a Hispanic Serving Institution (HSI) in 2017. HSIs are defined as institutions where over 25% of the student population identifies as Hispanic or Latine. The school is also designated an Asian American, Native American, Pacific Islander Serving Institution (AANAPISI) where over 25% of the students identify with one of those ethnic identities. Courses used for the study are all in STEM disciplines and have course enrollments of 100 students or more. This was decided upon due to literature suggesting that large courses create more challenging learning environments for student success (Cooper et al., 2018; Smith et al., 2013).

As mentioned above, academic success in the student-centered building (SCB) is a major focus of this study. The SCB is a multi-million-dollar investment that was built in order to encourage the facilitation of SCI teaching methods. The large lecture halls have chairs that swivel 360 degrees to promote more group work and wider rows so the instructor can walk through to interact more easily with students. The student-centered classrooms have seats grouped in pods of 6 to 8 with shared display monitors for students to work together on projects in the class, and whiteboards next to each pod so students can work out problems together. Traditionally structured classrooms including lecture halls or smaller classrooms with individual or fixed desks were also used in this study to compare the relationship of student-centered teaching practices with a traditionally structured building. In summary, this study will compare: 1) academic outcomes in a SCI course within the student-centered building 2) academic outcomes in a SCI course within a traditional building 3) academic outcomes in a didactic course within the student-centered building and 4) academic outcomes in a didactic course in a traditional building.

Data collection procedure

Classroom Observation Protocol Undergraduate STEM

The Classroom Observation Protocol for Undergraduate STEM (COPUS) was created to capture both instructor and student behaviors throughout a course period (Smith et al., 2013). Trained observers code from a list of actions what the instructor and students are doing at two-minute intervals. An example of the codes observers use for student actions are: "L-listening to instructor/taking notes," "CG-Discussing clicker question in groups of 2 or more", and "WG-working in groups for worksheet activity." Examples of the instructor codes are: "Lec-Lecturing (present content, deriving math results, presenting a problem)," "RtW-Real-time writing on the board," and "FUp-Follow-up/feedback on clicker question or activity to the entire class." There are a total of 13 student and 12 instructor behaviors that can be documented. Two classes per course included in this study were observed during the academic term. Five academic terms worth of data were collected for this study. After the COPUS data were collected, a k-means cluster analysis using all the codes was performed to better categorize the type of instruction in the courses surveyed. This method was used to create two clusters labeled as "interactive, or SCI" and "didactic," meaning more passive instructional strategies were used. Table 2.1 provides the demographics of courses in each cluster and Table 2.2 provides further detail of the codes used in the COPUS observation protocol.

Student academic and demographic collection.

Grade and institutional demographic information were pulled for each student in every course included in the study. Demographic information includes ethnicity, first-generation college student status, income level, as well as prior academic achievements such as SAT scores and GPA. Additionally, instructor demographics such as gender and faculty type were also pulled to control for instructor differences.

Data analysis

To answer the first research question, the student-centered building, first-generation Latine college students, and the interaction between both are the main predictors. The treatment was if the course was in the student-centered learning building. The outcome variable is the course grade. Below is the equation used for the stepwise regression:

$$Y=\beta_0 + \beta_1(\text{Student-Centered (SC) Building}) + \beta_2(\text{First-Generation Latine College Students}) + \beta_3(\text{SC Building*First-generation Latine students}) +\beta_4(\text{student controls})+ \beta_5(\text{instructor controls})+ \beta_6(\text{discipline controls})+ \beta_7(\text{Course composition controls})+a + e$$

Y is the course grade mentioned above. β_1 is if the course is held in the student-centered building. β_2 is if the student is both a first-generation college student and Latine. β_3 is an interaction between if the student's course is in the SC Building and if the student is a Latine first-generation college student to determine any moderation relationships. β_4 are student controls to take into account individual differences. These include ethnicity, being a first-generation college student, SAT scores and cumulative GPA. β_5 is instructor level covariates meant to control for instructor differences. These include gender and if the instructor is a teaching faculty member, meaning their primary role in the university is teaching. B_6 is the discipline level covariates that control for differences within each STEM discipline. These are gender, years having taught the course, and if they are research or teaching faculty. β_7 are course composition control for class size, the percentage of female students and the percentage of Latine students. Finally, term fixed effects were included to account for differences occurring between terms and standard errors by course were clustered to account for students being clustered within each course.

To answer the second research question, the student-centered building, underrepresented racially minoritized college students, and the interaction between both are the main predictors. The treatment was if the course was in the student-centered learning building. The outcome variable is again course grade. Below is the equation used for the stepwise regression:

$$Y=\beta_0 + \beta_1(\text{Student-Centered (SC) Building}) + \beta_2(\text{Underrepresented Racially Minoritized Students}) + \beta_3(\text{SC Building*Underrepresented Racially Minoritized college students})+\beta_4(\text{student controls})+ \beta_5(\text{instructor controls})+ \beta_6(\text{discipline controls})+ \beta_7(\text{Course composition controls})+a + e$$

Each part of the equation is similar to the one above. However, β_2 differs and instead is if the student is an underrepresented racially minoritized student. β_3 is an interaction between if the student's course is in the SC Building and if the student is an underrepresented racially minoritized college student to determine any moderation relationships.

Finally, to answer the third question, the student-centered building along with instruction style and Latine, first generation college students are used as main predictors for these analyses. Below is the equation for the stepwise regression:

$$Y=\beta_0 + \beta_1(\text{Student-Centered (SC) Building}) + \beta_2(\text{Type of Instruction and Building}) + \beta_3(\text{Type of Instruction and Building*Latine first generation college students/Underrepresented Racially Minoritized college students})+\beta_4(\text{student controls})+ \beta_5(\text{instructor controls})+ \beta_6(\text{discipline controls})+ \beta_7(\text{Course composition controls})+a + e$$

All controls and fixed effects are like the description above. However, β_2 represents if the course was in the SC building or a more traditional building and if the course used SCI or didactic instruction. There are four variables β_2 represents. These include: SCI course in a SC Building, SCI course in a regular building, didactic course in the SC building, and didactic course in a regular building. β_3 is an interaction between if the student's course is in the SC Building and the type of instruction used and if the student is a Latine first-generation college student or is an underrepresented racially minoritized college student in order to determine any moderation relationships. There are four variables β_3 represents. These include: SCI course in SC Building*URM, SCI course in regular building*URM, didactic course in SC building*URM, and didactic course in regular building*URM.

Results

First, Table 2.3 and Figure 2.1 presents descriptive information about the courses included in the study, the classroom type in which they were taught, and whether the course used SCI or didactic teaching methods. Table 2.3 provides the number of classrooms that were in the

SC Building as opposed to a traditional classroom, the number of students taught in each classroom type, the course averages for each type of building, and the amount of units Latine first-generation college students and the underrepresented racially minoritized groups were away from the mean. Figure 2.1 gives descriptive information for the four different course types—a course that uses SCI and is taught in the SC building, a course that uses SCI and is taught in a regular classroom, a course that uses didactic instruction and is taught in the SC building, and a course that uses didactic instruction and is taught in a regular classroom.

RQ1: Do student-centered classrooms increase the academic performance of Latine students compared to other race/ethnic groups?

Table 2.4 displays regression analyses for the relationship of course grades with the student-centered building. Without controlling for term fixed effects, lower course grades were related to being in the SC building (-0.114 standard deviation units). However, after controlling for term fixed effects, student, instructor and course composition controls, being in the student-centered building was not significant. There were also other factors that were related to differences in academic outcomes. First, being female, being in the physical sciences disciplines, and larger class enrollment is related to lower course grades. While being a first-generation college student, being Native, a higher cumulative GPA, and being a female instructor is related to higher course grades.

RQ3: Are there differences in academic outcomes when comparing student-centered courses and didactic courses within and not within the student-centered building?

Table 2.5 provides the regression analyses that estimates the relationship between course grades and the building type with the teaching method. Without controlling for term fixed effects, being in a traditional building while still incorporating student-centered instruction was related to higher course grades (0.330 standard deviation units). In contrast, using didactic instruction in the student-centered building was related to lower course grades (-0.148 standard deviation units). However, after controlling for term fixed effects, there was no significant relationship between course grades, building type, and instruction type. There is a relationship with other factors that were related to differences in academic outcomes. First, being a first-generation college student, Native, higher cumulative GPA are related to higher course grades while being a first-generation Latine student, being female, being in a physical sciences department, and higher class enrollment was related to lower course grades.

RQ 2: Do student-centered classrooms increase the academic performance of underrepresented racially minoritized students?

Table 2.6 displays the regression analyses for the relationship between course grades and the student-centered building. Without controlling for term fixed effects, being in the student-centered building is significantly related to lower course grades (-0.141 standard deviation units). However, the interaction between being in the student-centered building and being an underrepresented racially minoritized (URM) student is significantly related to lowering the negative main relationship of lower course grades when in a student-centered building by 0.052 standard deviation units. After controlling for term fixed effects and clustering the standard errors for each course, no significant relationship between course and building was found. However, being native, having a female instructor and higher cumulative GPA is related to higher course grades while being female, being in a physical sciences department and higher-class enrollment is related to lower course grades.

RQ3: Are there differences in academic outcomes when comparing student-centered courses and didactic courses within and not within the student-centered building?

Table 2.7 provides the regression analyses between course grades, type of instruction, and building. Without controlling for term fixed effects, using SCI in a regular building was related to higher course grades (0.317 standard deviation units). In contrast, using didactic instruction within the student-centered building was related to lower course grades (-0.197 standard deviation units). However, being a URM in a SCI course in the SC building increases their main relationship of higher course grade for being in a SCI course in the SC building by 0.069 standard deviation units. Furthermore, the interaction between being a URM in a didactic course in the SC building lowers the negative main relationship on course grades by 0.090 standard deviation units. After controlling for term fixed effects and clustering the standard errors by course, there were no significant relationships between course grades, type of instruction, and building. However, being a first-generation college student, Native, and higher cumulative GPA is related to higher course grades while being female, having a teaching instructor, being in a physical sciences discipline, and higher course enrollment was related to lower course grades.

Discussion

Before controlling for term fixed effects, results indicate that the type of instruction may have a possible relationship with higher course grades more so than the relationship between physical building. For example, being in a course which utilized SCI, independent of being in the SC building or regular building, was related to higher course grades. Furthermore, the interaction between being a Latine first- generation college student and being in a SCI course resulted in higher course grades regardless of building. This is particularly encouraging for institutions that do not have the resources to invest in newly built or renovated infrastructures. However, one limitation is that when term fixed effects are added to the model, all significance is lost.

Despite the limitation, when controlling for term fixed effects higher class size was related to lower course grades. This directly aligns with previous literature of the negative relationship class size has on course grades (Monks et al., 2011). In fact, previous research has indicated that often as class size grows, instructors begin to make decisions that can be detrimental towards student learning (Monks et al., 2011). This may highlight a need for more pedagogical training on student-centered practices in larger enrollment courses and physical learning environments that promote large classes to feel like smaller learning environments (Monk et al., 2011). Additionally, discipline was related to course grades. For example, physical sciences was related to lower course grades in all the tables. This suggests culture within a field may have a relationship with course grades.

Conclusion and Implications

This work highlights the importance of evaluating how a physical building may have a relationship with academic outcomes. Overall, this study suggests that instruction type, such as SCI or didactic, may contribute more to student outcomes than physical attributes of a building. However, future research should investigate further due to the elimination of significant relationships when including term fixed effects and clustering the standard errors by course. Another interesting finding includes the relationship between class size and discipline. Larger classes were related to lower course grades. This finding has pedagogical implications that instructors need professional development opportunities to learn how to appropriately engage students in larger class sizes. Additionally, differences in course grades for discipline suggests a need to investigate the teaching cultures and practices within STEM discipline to identify if there are any pedagogical needs within the discipline to help with STEM student success

Table 2.1 Demographic information of sample

	Total				Active				Didactic			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
Latine	22.4%	0.42	0	1	24.3%	0.43	0	1	20.4%	0.40	0	1
East Asian	23.6%	0.42	0	1	21.1%	0.41	0	1	24.9%	0.43	0	1
Southeast Asian	27.2%	0.46	0	1	27.6%	0.45	0	1	27.7%	0.45	0	1
Black	3.6%	0.19	0	1	3.8%	0.19	0	1	2.8%	0.17	0	1
Native	<1%	0.05	0	1	<1%	0.05	0	1	<1%	0.05	0	1
Indian	5.1%	0.22	0	1	5.0%	0.21	0	1	5.8%	0.23	0	1
White	13.1%	0.34	0	1	14.2%	0.35	0	1	13.3%	0.34	0	1
First Generation	47.2%	0.50	0	1	48.2%	0.50	0	1	45.3%	0.45	0	1
SAT Math	630.03	89.19	200	800	621.95	88.93	340	800	639.72	87.46	200	800
SAT Read	587.68	89.33	200	800	586.12	88.91	300	800	595.46	89.90	200	800
SAT Writing	581.24	83.15	230	800	579.25	83.91	320	800	587.78	82.61	230	800
Cumulative GPA	3.12	0.55	0	4	3.12	0.56	0	4	3.16	0.49	1	4
Discipline												
Biological Sciences	37.0%	0.46	0	1	52.8%	0.50	0	1	13.5%	0.34	0	1
Engineering	1.8%	0.17	0	1	<1%	0.05	0	1	3.6%	0.19	0	1
Computer Science and Informatics	14.1%	0.40	0	1	8.1%	0.27	0	1	21.8%	0.41	0	1
Physical Sciences	35.1%	0.47	0	1	26.1%	0.44	0	1	49.4%	0.50	0	1
Number of courses	83				52				31			

Table 2.2 COPUS categories

Instructor Codes	Definition	Student Codes	Definition
Instructor.Lec	Lecturing (presenting content, deriving mathematical results, presenting problem solution, etc.)	Student.L	Listening to instructor/taking notes, etc.
Instructor.RtW	Real-time writing on board, document projector, etc. (often checked off along with Lec)	Student.Ind	Individual thinking/problem solving. Only mark when an instructor explicitly asks students to think about a clicker question or another question/problem on their own.
Instructor.FUp	Follow-up/feedback on clicker question or activity to entire class	Student.CG	Discuss clicker question in groups of 2 or more students
Instructor.PQ	Posing non-clicker question to students (non-rhetorical)	Student.WG	Working in groups on worksheet activity
Instructor.CQ	Asking a clicker question (mark the entire time the instructor is using a clicker question not just when first asked)	Student.OG	Other assigned group activity, such as responding to instructor question
Instructor.AnQ	Listening to answering student questions with entire class listening	Student.AnQ	Student answering a question posed by the instructor with rest of class listening
Instructor.MG	Moving through class guiding ongoing student work during active learning task	Student.SQ	Student asks question

Instructor.1o1	One-on one extended discussion with one or a few indivduals, not paying attention to the rest of the class (can be along with MG or AnQ)	Student.WC	Engaged in whole class discussion by offering explanations, opinion, judgement, etc. to whole class, often facilitated by instructor
Instructor.DV	Showing or conducting a demo, experiment, simulation, video, or animation	Student.Prd	Making a predication about the outcome of demo or experiment
Instructor.Adm	Administration (assign homework, return tests, etc.)	Student.SP	Presentation by student(s)
Instructor.W	Waiting when there is an oportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor is not doing so	Student.TQ	Test or quiz
Instructor.Other	Other-explain in comments	Student.W	Waiting (instructor late, working on fixing AV problems, instructor otherwise occupied, etc.)
		Student.Other	Other-explain in comments

Table 2.3 Student-Centered Building and Regular Building Descriptive Information

	Student-Centered Building	Regular Building
Number of courses	63	20
Amount of student	20,624	4822
Courses Average (out of 4)	2.88	2.98
Latine First Generation College Students Average (out of 4)	2.60	2.67
Underrepresented racially minoritized Course Average (out of 4)	2.80	2.88

Table 2.4 Relationship between Student-Centered Building on Course Grades

	Model 1	Model 2	Model 3	Model 4
Student-Centered (SC) Building	-0.019	-0.138***	-0.114***	-0.136
	(0.01)	(0.01)	(0.01)	(0.12)
First Generation (FG), Latine Students	-0.062	-0.093*	-0.129***	-0.132
	(0.04)	(0.04)	(0.04)	(0.08)
SC Building* FG Latine	-0.008	0.003	0.036	0.035
	(0.03)	(0.03)	(0.03)	(0.10)
Student Controls				
Female	-0.047***	-0.050***	-0.051***	-0.051*
	(0.01)	(0.01)	(0.01)	(0.02)
First Generation College Students	0.049***	0.046***	0.045***	0.046***
	(0.01)	(0.01)	(0.01)	(0.01)
Latine	0.067*	0.085***	0.080**	0.078**
	(0.03)	(0.03)	(0.02)	(0.03)
East Asian	0.019	0.033*	0.036*	0.027
	(0.02)	(0.02)	(0.02)	(0.02)
Black	-0.028	-0.031	-0.025	-0.028
	(0.03)	(0.03)	(0.03)	(0.03)
Native	0.145	0.179	0.178	0.178**
	(0.11)	(0.11)	(0.10)	(0.07)
Pacific Islander	0.217	0.158	0.162	0.106
	(0.15)	(0.14)	(0.14)	(0.10)
Indian	0.009	0.029	0.036	0.025
	(0.03)	(0.02)	(0.02)	(0.03)

Southeast Asian	-0.014	0.011	0.016	0.011
	(0.02)	(0.02)	(0.02)	(0.02)
SAT Math	0.013	0.025***	0.027***	0.026
	(0.01)	(0.01)	(0.01)	(0.02)
Cumulative GPA	0.700***	0.692***	0.690***	0.691***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor Controls				
Instructor Female		0.253***	0.156***	0.143*
		(0.01)	(0.01)	(0.07)
Teaching Instructor		-0.253***	-0.182***	-0.129
		(0.02)	(0.02)	(0.08)
Discipline				
Physical Sciences		-0.377***	-0.446***	-0.421***
		(0.01)	(0.01)	(0.08)
Engineering		0.239***	0.138**	0.016
		(0.04)	(0.04)	(0.14)
Computer Science		-0.246***	-0.145***	-0.190
		(0.02)	(0.03)	(0.18)
Course Composition				
Class Enrollment			-0.141***	-0.147***
			(0.01)	(0.04)
Number of Female Students			0.045***	0.024
			(0.01)	(0.07)
Number of Latine Students			0.054***	0.054
			(0.01)	(0.06)
Term Fixed Effects				^^
N	21884	21764	21764	21764

Note. White is omitted as a comparison group for race. Biological Sciences is omitted as a comparison group for discipline. ^^ indicates Term Fixed Effects and standard errors were clustered by course in this particular model *p<0.05, **p<0.01, ***p<0.0001

Table 2.5 Relationship between Student-Centered Instruction and Student-Centered Building on Course Grades

	Model 1	Model 2	Model 3	Model 4
Student-Centered (SC) Building	0.286***	0.029	-0.001	-0.056
	(0.04)	(0.04)	(0.04)	(0.17)
SCI in SC Building	-0.135***	-0.014	0.010	0.022
	(0.04)	(0.04)	(0.04)	(0.13)
SCI in Regular Building	0.602***	0.360***	0.317***	0.248^^
	(0.04)	(0.04)	(0.04)	(0.18)
Didactic in SC Building	-0.433***	-0.263***	-0.197***	-0.135
	(0.04)	(0.04)	(0.04)	(0.14)
URM*SCI in SC Building	0.076**	0.063*	0.069**	0.053
	(0.03)	(0.03)	(0.03)	(0.06)
URM*SCI in Regular Building	0.182**	0.121*	0.109	0.134
	(0.06)	(0.06)	(0.06)	(0.08)
URM*Didactic in SC Building	0.082**	0.084**	0.090**	0.062
	(0.03)	(0.03)	(0.03)	(0.07)
Student Controls				
Female	-0.070***	-0.057***	-0.053***	-0.053*
	(0.01)	(0.01)	(0.01)	(0.02)
First Generation College Student	0.041***	0.031**	0.030**	0.029*
	(0.01)	(0.01)	(0.01)	(0.01)

Latine	-0.051	-0.039	-0.048	-0.038
	(0.03)	(0.03)	(0.03)	(0.04)
East Asian	0.019	0.029	0.034*	0.027^^
	(0.02)	(0.02)	(0.02)	(0.02)
Black	-0.035	-0.035	-0.026	-0.026
	(0.03)	(0.03)	(0.03)	(0.03)
Native	0.157	0.186	0.188	0.190**
	(0.11)	(0.10)	(0.10)	(0.07)
Pacific Islander	0.186	0.143	0.153	0.111
	(0.14)	(0.14)	(0.14)	(0.11)
Indian	0.021	0.032	0.036	0.026
	(0.02)	(0.02)	(0.02)	(0.03)
Southeast Asian	-0.078**	-0.046	-0.047	-0.035
	(0.03)	(0.03)	(0.03)	(0.05)
SAT Math	0.026***	0.029***	0.026***	0.025
	(0.01)	(0.01)	(0.01)	(0.02)
Cumulative GPA	0.698***	0.693***	0.688***	0.688***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor Controls				
Instructor Female		0.204***	0.139***	0.130^^
		(0.01)	(0.01)	(0.07)
Teaching Instructor		-0.254***	-0.200***	-0.145*
		(0.02)	(0.02)	(0.07)
Discipline				
Physical Sciences		-0.258***	-0.350***	-0.350***
		(0.01)	(0.01)	(0.10)
Engineering		0.391***	0.264***	0.128

		(0.04)	(0.04)	(0.15)
Computer Science		-0.128***	-0.146***	-0.198
		(0.02)	(0.03)	(0.17)
Course Composition				
Class Enrollment			-0.127***	-0.134**
			(0.01)	(0.05)
Number of Female Students			0.012	-0.002
			(0.01)	(0.08)
Number of URM Students			0.021	0.022
			(0.01)	(0.07)
Term Fixed Effects				^^
N	22153	22005	22005	22005

Note. White is omitted as a comparison group for race. Biological Sciences is omitted as a comparison group for discipline. ^^ indicates Term Fixed Effects and standard errors were clustered by course in this particular model *p<0.05, **p<0.01, ***p<0.0001

Table 2.6 Relationship between Student-Centered Instruction and Student-Centered Building on Course Grades

	Model 1	Model 2	Model 3	Model 4
Student-Centered (SC) Building	0.292***	0.036	-0.010	-0.070
	(0.04)	(0.04)	(0.04)	(0.18)
First Generation (FG), Latine Students	-0.118**	-0.135***	-0.157***	-0.162*
	(0.04)	(0.04)	(0.04)	(0.07)
SCI in SC Building	-0.112**	0.000	0.036	0.041
	(0.04)	(0.04)	(0.04)	(0.13)
SCI in Regular Building	0.676***	0.392***	0.330***	0.273
	(0.03)	(0.03)	(0.04)	(0.17)
Didactic in SC Building	-0.401***	-0.231***	-0.148***	-0.094
	(0.04)	(0.04)	(0.04)	(0.15)
SCI in SC Building*FG Latine	0.058	0.060	0.084*	0.092
	(0.04)	(0.03)	(0.03)	(0.09)
SCI in Regular Building* FG Latine	0.108	0.148*	0.142*	0.130
	(0.07)	(0.07)	(0.07)	(0.15)
Didactic in SC Building*FG Latine	0.020	0.012	0.024	0.009
	(0.04)	(0.04)	(0.04)	(0.10)
Student Controls				
Female	-0.070***	-0.057***	-0.052***	-0.052*

	(0.01)	(0.01)	(0.01)	(0.02)
First Generation College Students	0.056***	0.049***	0.048***	0.048***
	(0.01)	(0.01)	(0.01)	(0.01)
Latine	0.068**	0.083***	0.080***	0.079**
	(0.03)	(0.02)	(0.02)	(0.03)
East Asian	0.018	0.028	0.031	0.024
	(0.02)	(0.02)	(0.02)	(0.02)
Black	-0.038	-0.038	-0.031	-0.031
	(0.03)	(0.03)	(0.03)	(0.03)
Native	0.160	0.188	0.188	0.189**
	(0.11)	(0.10)	(0.10)	(0.07)
Pacific Islander	0.185	0.142	0.149	0.103
	(0.14)	(0.14)	(0.14)	(0.11)
Indian	0.022	0.033	0.037	0.028
	(0.02)	(0.02)	(0.02)	(0.03)
Southeast Asian	-0.014	0.009	0.014	0.011
	(0.02)	(0.02)	(0.02)	(0.02)
SAT Math	0.026***	0.029***	0.028***	0.027
	(0.01)	(0.01)	(0.01)	(0.02)
Cumulative GPA	0.697***	0.692***	0.689***	0.689***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor Controls				
Instructor Female		0.204***	0.135***	0.125^^
		(0.01)	(0.01)	(0.06)
Teaching Instructor		-0.257***	-0.195***	-0.137^^
		(0.02)	(0.02)	(0.07)

Discipline				
Physical Sciences		-0.258***	-0.346***	-0.346***
		(0.01)	(0.01)	(0.09)
Engineering		0.394***	0.254***	0.113
		(0.04)	(0.04)	(0.16)
Computer Science		-0.128***	-0.136***	-0.183
		(0.02)	(0.03)	(0.18)
Course Composition				
Class Enrollment			-0.127***	-0.134**
			(0.01)	(0.04)
Number of Female Students			0.017	0.002
			(0.01)	(0.07)
Number of Latine Students			0.027**	0.034
			(0.01)	(0.05)
Term Fixed Effects				^^
N	22153	22005	22005	22005

Note. White is omitted as a comparison group for race. Biological Sciences is omitted as a comparison group for discipline. ^^ indicates Term Fixed Effects and standard errors were clustered by course in this particular model
*p<0.05, **p<0.01, ***p<0.0001

Table 2.7 Relationship between Student-Centered Building on Course Grades

	Model 1	Model 2	Model 3	Model 4
Student-Centered (SC) Building	-0.038*	-0.164***	-0.141***	-0.145
	(0.02)	(0.02)	(0.02)	(0.12)
SC Building*URM	0.026	0.044	0.052*	0.023
	(0.03)	(0.02)	(0.02)	(0.06)
Student Controls				
Female	-0.048***	-0.050***	-0.052***	-0.052*
	(0.01)	(0.01)	(0.01)	(0.02)
First Generation College Students	0.038***	0.030**	0.029**	0.028*
	(0.01)	(0.01)	(0.01)	(0.01)
Latine	0.002	-0.011	-0.024	-0.005
	(0.03)	(0.03)	(0.03)	(0.05)
East Asian	0.019	0.031	0.038*	0.030
	(0.02)	(0.02)	(0.02)	(0.02)
Black	-0.027	-0.030	-0.021	-0.023
	(0.03)	(0.03)	(0.03)	(0.03)
Native	0.154	0.190	0.189	0.190**
	(0.11)	(0.11)	(0.10)	(0.07)
Pacific Islander	0.213	0.154	0.168	0.115
	(0.15)	(0.14)	(0.14)	(0.11)
Indian	0.014	0.031	0.035	0.025
	(0.02)	(0.02)	(0.02)	(0.03)
Southeast Asian	-0.032	-0.021	-0.026	-0.005
	(0.03)	(0.02)	(0.02)	(0.05)
SAT Math	0.013*	0.026***	0.025***	0.024
	(0.01)	(0.01)	(0.01)	(0.02)

Cumulative GPA	0.699***	0.691***	0.686***	0.687***
	(0.01)	(0.01)	(0.01)	(0.03)
Instructor Controls				
Instructor Female		0.251***	0.166***	0.148*
		(0.01)	(0.01)	(0.07)
Teaching Instructor		-0.246***	-0.186***	-0.133^^
		(0.02)	(0.02)	(0.07)
Discipline				
Physical Sciences		-0.370***	-0.452***	- 0.426***
		(0.01)	(0.01)	(0.08)
Engineering		0.239***	0.162***	0.044
		(0.04)	(0.04)	(0.14)
Computer Science		-0.231***	-0.164***	-0.218
		(0.02)	(0.03)	(0.17)
Class Enrollment				
Class Enrollment			-0.146***	- 0.153***
			(0.01)	(0.04)
Number of Female Students			0.040***	0.021
			(0.01)	(0.08)
Number of URM Students			0.035*	0.026
			(0.01)	(0.07)
Term Fixed Effects				^^
N	22153	22005	22005	22005

Note. White is omitted as a comparison group for race. Biological Sciences is omitted as a comparison group for discipline. ^^ indicates Term Fixed Effects and standard errors were clustered by course in this particular model *p<0.05, **p<0.01, ***p<0.0001

Figure 2.1 Building by Instruction Type Descriptive Information

SCI in Regular Building How many classrooms: 5 How many students: 971 Courses Average (out of 4): 3.43 Latine First Generation College Students Average (out of 4) : 3.20 Underrepresented racially minoritized Course Average (out of 4): 3.32	SCI in SC Building How many classrooms: 47 How many students: 14074 Courses Average (out of 4): 2.98 Latine First Generation College Students Average (out of 4) : 2.70 Underrepresented racially minoritized Course Average (out of 4): 2.91
Didactic in Regular Building How many classrooms: 15 How many students 3851 Courses Average (out of 4): 2.87 Latine First Generation College Students Average (out of 4) : 2.50 Underrepresented racially minoritized Course Average (out of 4): 2.76	Didactic in SC Building How many classrooms: 16 How many students: 6550 Courses Average (out of 4): 2.67 Latine First Generation College Students Average (out of 4) : 2.36 Underrepresented racially minoritized Course Average (out of 4): 2.56

CHAPTER 4: STUDY 3—"Oh they're first generation? I can do it too": Experiences of racially minoritized first generation college students in a student-centered course

Lack of representation of minoritized students in higher education STEM programs contributes to an insufficient amount of diversity in STEM fields (NSF 2015), leading to nationwide calls to improve instruction. Previous research has shown positive outcomes on student learning and improved innovative thinking with student-centered learning strategies (Harackiewicz et al., 2014; Haak et. al. 2011). Student-centered learning can be defined as instruction focused on increasing student involvement in the classroom by including more peer to peer and student to instructor interaction (Serin, 2018). This differs from more traditional instructional practices used in higher education STEM courses that are more passive in nature with the primary instructional activity being instructor lecturing (Stains et al., 2018). In addition to the identified learning gains from student-centered instruction, previous research has asserted that it is particularly helpful for minoritized students and promotes an increase in academic outcomes and improved perception of self-efficacy (Ballen et al., 2018; Theobald et al., 2020). While work has uncovered surface-level information regarding the student perspective of student-centered learning (Braxton et al., 2000), it has not focused on elevating the student voice, particularly for minoritized students. In this work, I aim to present the student perspective of student-centered instructional practices. Specifically, this work aims to focus on the racially minoritized first-generation college student perspective in a Hispanic Serving Institution (HSI) and an Asian American, Native American, Pacific Islander Serving Institution (AANAPISI). HSIs and AANAPISIs are Minority Serving Institutions (MSIs) that receive money to specifically support these populations. HSIs have more than 25% of students that identify as

Latine or Hispanic. AANAPISIs have over 25% that identify as one or more of the listed ethnic groups. Not only does this study focus on student perspective in student-centered courses, but also within the HSI and AANAPISI context.

Theoretical Framework: Community of cultural wealth

Tara Yosso's community of cultural wealth framework moves away from the idea that underrepresented and minoritized students come into the higher education classroom with certain deficiencies. Instead, the focus is to move toward an understanding that these students enter with assets that may be beneficial for themselves and their peers (Yosso, 2005). These assets may manifest more frequently and be more beneficial to student success in a classroom where the instructor uses student-centered instruction due to the increase in social interaction. Yosso describes 6 different types of "cultural capital" in this framework include linguistic capital, social capital, navigational capital, aspirational capital, familial capital, and resistant capital, which are defined below.

Linguistic capital includes the intellectual and social skills attained through communication experiences in more than one language and/or style. As student-centered courses involve considerable peer to peer interaction, this may provide the opportunity for students to speak to each other in ways that are more authentic to them to understand the material.

Social capital includes peer and other social contacts that provide influential and emotional support. From group discussions with peers or interactions with the instructor, students are provided with increased opportunities to generate support and feelings of community in a student-centered classroom.

Navigational capital includes skills learned to maneuver through social institutions, such as the higher education system, that traditionally have not been established with underrepresented students' cultural norms in mind.

While linguistic, social, and navigational capital focus more on building relationships to learn how to navigate society, *aspirational capital* is focused on the individual's ability to maintain hopes that they will accomplish their dreams despite substantial structural barriers present that may impede them.

Individuals may have aspirational capital due to their pre-college relationships with family leading to *familial capital* that creates communal networks that lead for hope and dreams to continue to help the individuals in this network thrive.

Finally, and connected to familial capital, *resistant capital* is the desire to secure equal rights and freedom and is influenced by injustices witnessed in their family and community relationships. Each of these types of capital are interconnected, so students may use multiple forms of capital to help them thrive while in college.

Student-centered courses generate increased opportunities for feedback for minoritized students to understand how they may be successful in collegiate level STEM courses. Thus, student-centered learning environments may leverage a variety of assets that minoritized students possess that are not applicable or leveraged in a didactic classroom. However, it is currently unclear whether this hypothesis is accurate. The following study seeks to understand the racially minoritized first generation college students, who I will refer to as "minoritized students" here-forth, perspectives of student-centered instruction in a Hispanic Serving Institution (HSI) and a Asian American, Native American, Pacific Islander Serving Institution (AANAPISI).

Literature Review

First generation college students' challenges

In study 1 and study 2 the focus was on the context of racially minoritized students. However, I hypothesize that first-generation college students may have similar experiences due to previous research finding first-generation college students' experience lower success rate in college. Indeed, first generation college students were much less likely to earn degrees than their college-going parents' peers. (Engle, 2007). Being a first-generation college student has also been found to correlate with lower academic achievement (Strayhorn, 2006).

Alongside academic challenges, first generation students experience lower social integration, culture shock, and feelings of isolation (Lubrano, 2004). Many feel a discontinuity between their familial culture and the culture prevalent on college campuses (Engles, 2007). For example, many first-generation students' families do not understand what students are going through and are unable to help them navigate the college-going culture and process. Additionally, due to financial challenges, first-generation students are more likely to hold a part-time or full-time job while attending college, leaving less time for creating social circles, participating in study groups, and interacting with faculty (Lubrano, 2004). These social challenges are often exacerbated for racially minoritized students. Orbe (2004) found that being a first-generation college student was particularly a salient part of the identity for racially minoritized students. Due to the intersectionality of experiences and the increased academic challenges experienced by those at these intersections, there is a pressing need to focus research on racially minoritized, first-generation college students (Stephens et al., 2012).

Possible impacts of student-centered instruction in STEM on minoritized students

As previously discussed, research has shown that student-centered instruction (SCI) may be a key step to increase the representation and persistence of minoritized students in STEM fields (Harackiewicz et al., 2014; Haak et. al. 2011). In fact, previous research has suggested that minoritized students may benefit more from STEM SCI courses than traditional students. In a double-blind, randomized experiment implementing student-centered learning strategies that focused on increasing task value, researchers found that first-generation minoritized students had an increase in interest in biology while also reducing the achievement gap in the class by 61% (Harackiewcz et al., 2016). Improved course performance was a focus in other studies as well. One found that SCI teaching methods increased course performance for all students, but disproportionately so for first-generation Black college students (Eddy & Hogan, 2014). Implementing methods such as daily and weekly practice problems, an emphasis on data analysis and other higher-order cognitive thinking skills, and considerable group work, decreased achievement gaps (Haak et al., 2011). Despite positive findings of SCI and its relationship with minoritized students, few studies have investigated the student perspective of SCI, particularly for these students who appear to be most positively affected.

Study Contribution

This study focuses on the minoritized first-generation college student perspective on student centered instruction (SCI) to understand how it is impacting their learning. This study contributes to the literature by examining whether such courses allow for students to display and use assets and strengths which they do not have the opportunity to leverage in didactic courses. For this study, I theorized that we may see examples of linguistic, social, and navigational capital manifested by first-generation and minoritized students experiencing SCI. As student-centered courses involve considerable peer to peer interaction, this may provide the opportunity for minoritized students to speak to each other in ways that are more authentic to them to understand the material. This would be an example of linguistic capital, which includes the intellectual and social skills attained through communication experiences in more than one language and/or style (Yosso, 2005). Social capital includes peer and other social contacts that provide influential and emotional support (Yosso, 2005), which may arise from group discussions with peers or interactions with the instructor. These interactions provide students with increased opportunities to generate support and feelings of community in a student-centered classroom. And finally, student-centered courses generate increased opportunities for feedback for minoritized students to better understand how to be successful in a collegiate level STEM course. This will enable the acquisition of navigational capital, which includes skills learned to maneuver through social institutions, such as the higher education system, that traditionally have not been established with minoritized students' cultural norms in mind (Yosso, 2005). Thus, student-centered learning environments may leverage a variety of assets that minoritized students possess that are less likely to arise in a didactic classroom. Figure 3.1 provides a visual of my hypothesis of how the types of capital are utilized in SCI courses.

Research Questions

1. How do minoritized students verbalize their learning in a student-centered classroom?
2. What do minoritized first-generation college students believe contributes to a successful student-centered learning environment?
3. Utilizing Yosso's community of cultural wealth, what forms of capital are utilized and developed in the student-centered classroom?

Method

Study Context

To explore these research questions, interviews were conducted with 11 minoritized students in a student-centered course at a Hispanic Serving Institution (HSI) and Asian American/Native American/Pacific Islander Serving Institution (AANAPISI) R1 doctoral-granting university. To be designated an HSI, at least 25% of students must identify as Hispanic or Latine. Similar requirements are needed to be designated as an AANAPISI with at least 25% of students needing to identify as Asian American, Native American or Pacific Islander. The selected course was an introductory biological sciences course with over 400 students enrolled that incorporated significant student-centered instruction and utilized a high-structure format. For example, the instructor would lecture for 10 minutes or less in a single class period. The remaining time was used for active learning activities, including having students diagram an experiment (called 'cartooning') and being given hypothetical scenarios they would discuss with their peers to formulate an answer. While discussing with peers, graduate teaching assistants and undergraduate learning assistants would walk up and down the aisles to engage students who may not be discussing with peers and answer any questions. The class was approximately 30% racially minoritized students (the vast majority of which are Latine), 40% low-income students, and 50% first-generation college students.

Data Collection and Participants

The interview protocol was created by reviewing the literature and drafting questions with Yosso's framework in mind. Appendix 3.1 provides the interview questions. Each question was crafted to gain students' perspectives of how SCI methods help or hinder their learning and allow students to use their own strengths and assets to be successful in courses. This was accomplished by drafting questions where students discuss teaching methods being used and how they may be beneficial or detrimental to their learning. The protocol also gave students the opportunity to compare their experience in a student-centered course rather than a didactic course and how they used their own strengths in each setting. Additional probing was used to identify whether specific types of capital were cited as tools to help the interviewed students succeed.

After drafting an interview protocol, questions were given to other qualitative researchers for feedback and revised. Six of the students interviewed identified as Latine and five identified as Southeast Asian with seven being female and four males. I included Southeast Asian as part of the interview group as they traditionally underperform academically in STEM courses and typically come from lower-income backgrounds (Toldson, 2012). I also interviewed two undergraduate learning assistants who had taken the course previously and now helped to facilitate discussion during lecture. The undergraduate learning assistants were interviewed to capture their experiences with students and what they observed these students doing in the classroom. Both learning assistants were male and identified as Asian American. Course observations were also conducted to observe instructional strategies being used and student reactions to the teaching methods. Meticulous field notes were taken and are used in the analysis. Participants were recruited based on their status as a racially minoritized student and a first-generation college student. The interviews were transcribed, and the research team used an inductive and deductive process based on previous research to create a comprehensive codebook. Table 3.1 displays the codebook with each code and its definition.

Researcher positionality

As a first-generation college student who identifies as being biracial—both Latina and White—telling the stories of racially minoritized students in higher education is my passion. Despite my connection to the Latine community, I do recognize my privilege of being "White passing" and understand that my own college experiences may be very different from those of the students who were included in this study. Additionally, as a previous educator, I also recognize my own biases of what is "good teaching" due to being trained as a K-12 educator. Recognizing my own biases and continuously questioning my findings to be as objective as possible is something that I strive to accomplish and use evidence-based approached to mitigate my biases (Walther et al., 2013).

Results

The following section is organized based on the research questions. Each question section has themes revealed from the data analyses.

Research Question 1. How do minoritized students verbalize their learning in a student-centered classroom?

Conflicting Perceptions of Learning in Student-Centered versus Didactic Classrooms

When students spoke about their learning, they gave conflicting definitions depending on whether they were referencing a student-centered or didactic classroom. For example, in didactic classes, students saw learning as memorization of material. On the other hand, hallmarks of learning in student-centered courses included the application of concepts and greater retention of course material.

For example, one student described learning in a didactic course as:

"It sounds lazy, but I learn when you tell me. If you teach it to me, I can get it. In this [student-centered] class, it's not told to us directly."

Another student described a professor she has for a more didactic course as:

"My professor's really good at her lecture notes. She gives you her lecture notes in advance. You go and buy them from the bookstore. She has them pre-written down, and some of its missing so you go to class and you fill it out. Having these notes written for me helps me learn."

These quotes highlight the students desire to be given the knowledge directly and more passively rather than other forms of instruction. However, when discussing a student-centered class, the same students viewed learning differently:

"I think it's helpful listening to other people explain problems or try to. Even if it's wrong, like, Okay I was thinking that, too. It's wrong. Okay. I know that's not right so I'm going to listen to this person next. You can eliminate options. It just really helps when you're trying to decipher a problem on your own to hear other people's opinions about it…I retain a lot of information that way."

The other student described the student-centered course as:

"I find it actually easier to get a good grade in. Because you are forced to do the reading. You are forced to take these exams in a certain way. And I like that. It helps. Because you're actually going to learn and remember what you go over in the class."

These quotes highlighted that the student perception of learning was context-specific and varied based on the course structure.

Research Question 2. What do first-generation college students of color believe contributes to a successful student-centered learning environment?

Multiple Teaching Methods Used to Access Material

Most students perceived a strong student-centered learning environment as having a variety of opportunities to learn the material through differing instructional strategies and consistent peer interaction. One student stated "*I think it helps you meet other people and really work together to get to the answer. It feels like a smaller group even though we're a bunch of people [in a large lecture].*" This quote highlights how peer interaction allowed students to feel less like a number in a large classroom. Another student explained further:

> "*Afterwards you kind of just find each other in every lecture, so you get close. But otherwise in other[didactic] lectures I just sit wherever I happen to sit for that day. I don't remember who sits next to me or even who's in the class… I feel like you get less attention, and then some people might just fall through the crack."*

This quote highlights didactic classrooms with only lecture-based instruction provide fewer opportunities to make peer connections and feel as if one belongs in the course. Students also explained their appreciation of multiple avenues of learning. As one student writes:

> *"One thing I like about them is that even if you don't understand it one way, there's always another way, like a different approach to it. So, if I don't understand [subject X]…I can just look at the diagram he has up on the board. Or*

if I don't understand the readings, then I can just discuss it with my friend who did understand it. For questions, there's also the message board.”

This student emphasizes how if they don’t understand one teaching method, they can find a different method either in the class, speaking with peers, or using the virtual learning management system. This ability to learn from different modes provides students with the opportunity to learn material they may not in a didactic course that focuses on the teaching method of lecturing.

Importance of Instructor Facilitation

All but one student also recognized the importance of the instructor in student-centered courses. Students were observant of the instructors’ practices and classroom management. One student stated:

> “*He would ask questions; he would tell us to discuss amongst ourselves. It was really helpful…The professor did ask questions, ‘Hey, could somebody tell me this?’ And he would really stop and make sure everybody was paying attention, it was really engaging”.*

On the other hand, in reference to the discussion sections which were led by graduate students, another student noted:

> *"I just felt like the questions the [discussion section TA] asked were not very relevant. They were really hard questions and when they did go over it, they went over it too fast…They let us work in groups, but a lot of the time by the time they got to explaining, it was really rushed.”*

Similar instructor to TA comparisons were made concerning the importance of an instructor encouraging (or not encouraging) student participation and how the instructor facilitated the class was important and was something students recognized as being important for their course experience and student learning.

Research Question 3. Utilizing Yosso's community of cultural wealth, what forms of capital do we see evidence for in the student-centered classroom?

From the interviews, I identified examples of both linguistic and social capital being manifested in a student-centered classroom.

Linguistic Capital

From the interviews, it was clear that Latine students valued being able to communicate with others from a similar background. For example, students found the use of Spanglish to be helpful in group discussions. One student said:

> *[In my group] they're all Mexicans. Me and my roommate are in that class, so we were together. And then another one of our friends was also with us. And so it was usually the three of us so we could speak Spanglish which was nice.*

This implies greater comfort and feelings of confidence when given the opportunity to discuss concepts from the course in a way most authentic to them that they may not have the opportunity to do so otherwise. This was not something discussed by the Southeast Asian students as being particularly important for them during peer group discussion.

Social Capital

Further, Latine students reported the support structures created through the group interactions. One student said:

> *I feel like there are a lot of first generation, Latino students that I've talked to which is nice. They are also trying to figure it out, sometimes they are doing such a good job it makes you think, "Like, oh they're first generation, I can do it too."*

This quote highlights the gain in confidence and self-efficacy from working with others like them who understand their own life experiences. This is especially helpful in STEM environments where there are fewer opportunities to interact with Latine students (National Academies of Sciences, Engineering, and Medicine). Interestingly, none of the Southeast Asian students mentioned their ethnic identity when discussing peer interactions. However, many discussed the benefits of working with peers to answer discussion questions. One (Southeast Asian) student stated: *"I share my answers with my friends in class and in small group setting, but never in a lecture hall."* This quote highlights that for students providing this safe space to discuss the material is important but being able to select who you are speaking to may matter more for Latine students to feel comfortable.

Discussion and Conclusion

The results highlight that Latine students utilized their social and linguistic capital in the student-centered classroom which they reported benefited them in the class to feel more confident and create social networks with their peers. However, no such descriptions were provided from Southeast Asian students. This may be due to many students being of Asian descent in the biological sciences program from this study, signaling that while as a group they typically underperform relative to students of Japanese, Korean, or Chinese descent or White students, Southeast Asian students may not perceive themselves as underrepresented or minoritized. On the other hand, Latine students often look different from most of their peers. Excerpts also reveal how students' concepts of learning differ depending on the type of course and its expectations for student interaction. For example, in a more didactic classroom, students perceive learning as being memorization while in the student-centered classroom learning is retaining the information and the ability to apply the information by using critical thinking skills.

This work has direct implications for higher education STEM courses and the success of minoritized students. Firstly, student-centered practices should be used in the STEM classroom because they benefit students for reasons that go beyond course content gains. Students reported they felt able to retain the course material for longer and better comprehend the discussed concepts, while also expressing an increased feeling of belonging in the class and improved confidence. This work also highlights the value of being able to select their group as opposed to it being assigned. While some work has speculated that assigning groups is more beneficial to eliminate cliques and increase group diversity (Schreiber & Valle, 2013), I would argue that particularly for Latine students, giving the students a allows them to interact with similar peers and may lead to more positive classroom experiences and enable students to leverage their linguistic and social capital.

Perhaps most importantly, this work provides more evidence of an asset-based mindset as opposed to the deficit-based mindset that minoritized first-generation college students underperform because they lack certain skills. By providing these students with classrooms that leverage their unique strengths, we are creating more inclusive environments which will lead to greater academic success.

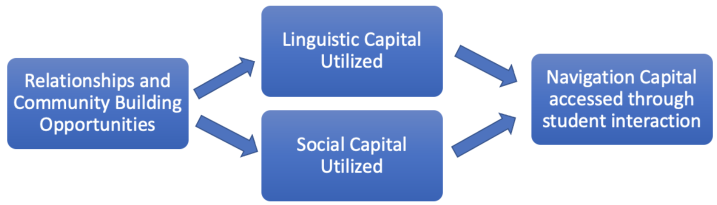
Table 3.1 Coding Framework

Categories	Codes	Definition
University		
	Encourager	had an individual who motivated and supported them to attend college (any)
	Environment	they liked "vibes"--how it made them feel (i.e., went on a campus)
	Applicable Skills	skills they are going to use in real life i.e., nursing program with fieldwork
Course		
	Social-Friend Interaction Only	During course activities, there few expansions social networks (people spoke to the same people every time)
	Helpful	found to be beneficial for learning
	Unhelpful	found to not be beneficial for learning
	Deeper Learning (i.e., applying information)	they acquired the information at a higher level (ex: they remembered the information for longer)
	Frustration (i.e., no direct help)	Lack of direction, wanted lecturing
	Opportunities	internship or other connections they have made in the course
Instructional Strategies	Step by Step	
	Group Discussion	group discussion questions asked to the students during class. requires them to speak to others and often involves a clicker question
	Pre-Lecture Quiz	quizzes they took about the reading that are mandatory before lecture that are timed.
	Reading	pre-reading students did before class
	Discussion Section	separate section meant to discuss topics from class
	Podcast	recording of the class
	Discussion Board	Canvas and is a place for students to ask questions and the instructor answer

	drawing figures/cartoons	
	Flipped Fridays	
	connections to the real world	professor connecting topics to real world applications (i.e., in a lab setting or in a doctor's setting)
	Classtime Lecture	
	Notes	
Compare with other courses	Comparison with traditional class	comparison with a more tradition class
	comparison with active class	comparison with other active class (Schaffer, Kondandale)
Student Traits	hard working	hard working
	previous experience	they have taken an active learning class
	insecure in ability	they don't think they can do well in the sciences
	Culture	When interviewer discusses how culture is represented or discussed in the class
	Neutral STEM belonging	indifference to STEM courses and feeling as if they belong
	Creative	
	Engaged in Class	
Professor Traits	Down to earth	
	passionate	
	helpful	
	knowledgeable	
	organized	
	disorganized	

	Caring	
	vague	
	overall negative	
Suggestion to improve courses	instructional strategies	strategies the instructor uses to teach (i.e., using real world applications)
	structure	class structure such as the sequence of the class or everyday class practices

Figure 3.1 provides a visualization of how Yosso's theory may be utilized in a student-centered course



Appendix 3.1 Interview protocol

1. Previous educational background
    - Could you tell me a little about where you grew up?
    - How would you best describe the community where you grew up?
    - What city did you grow up in?
    - If you had to use three adjectives, how would you describe where you grew up?
    - Can you give me an example
2. Family background (participants were reminded that they did not need to answer these questions if they did not want to)
    - What is the highest level of education that your parents or guardians completed?
        - If they went to college, what major were they?
    - What are their current occupations?
        - Where do they work at?
    - What kinds of messages did your parents send about education? How have those messages influenced you?
        - What kinds of things do your parents say about education?
        - How has this influenced you?
3. College information
    - When and why did you decide to go to college and choose UCI?
        - Why did you choose to go to UCI?
    - What are you majoring in? How did you choose this major?
        - What is your major? why?
    - What are you plans for the future?
        - What are your future plans?
4. “This course” experiences [this will be tailored to the particular course and course structure]
    - How would you describe what happens inside and outside of lecture for this course?
    - What do you think about this type of course structure overall?
        - Overall what do you think of the activities in the course?
    - Are there specific things you do in or outside of the lecture periods that you would like to comment on in more detail?
- Who do you think does well in you STEM classes?
- What character traits do they have?
- Do you feel like you belong in the classroom?
    - What are some ways you feel like you belong in your undergrad STEM classes?
    - What are some ways that you do not?

CHAPTER 5: DISCUSSION

There is a need in higher education to improve STEM instruction to increase retention, particularly for minoritized students. Previous research has discussed the benefits of student-centered instruction (SCI) (Theobald, 2020). However, less is known about the relationship of SCI with outcomes other than course grades, and the student perspective of SCI teaching methods are less prevalent in the literature. Additionally, much of the literature combines all minoritized students together from a variety of settings despite heterogeneous differences between types of university contexts and racially minoritized groups. To address these gaps, Study 1 surveyed students to assess psychosocial and motivational outcomes comparing students in SCI courses with didactic courses. This study also assesses if there are any differences that are particularly true for the Latine students in the course. Study 2 assesses academic differences between Latine students and other ethnic groups in a course and compares these differences in four different settings: 1) SCI course within the student-centered building 2) SCI course within a traditional building 3) didactic course within the student-centered building and 4) didactic course in a traditional building. Study 3 investigated the minoritized student perspective of SCI and the types of capitals they may be able to utilize within a SCI course.

Summary of Key Findings

Study 1

This study utilized a student survey that measured student perspectives of relationship building with peers and instructor, test anxiety, self-efficacy, and task value. The survey was given in Week 9 in 57 different STEM courses. Utilizing the Characterizing Observation

Protocol for Undergraduate STEM (COPUS) courses to assess if a course is student-centered, I found that being in a SCI course was related to significantly more peer relationships than the didactic courses. However, test anxiety was significantly higher in SCI courses when compared to didactic courses. Additionally, the diversity of the course was found to be significant as the number of Latine students within a course and being in a SCI course was significantly found to lower test anxiety. For motivational outcomes, being in a SCI course significantly increased the odds of having stronger self-efficacy when compared to the didactic courses. Despite higher test anxiety, this study results suggest that SCI may allow for students to create stronger support systems with their peers and gain higher self-efficacy.

Study 2

This study utilized COPUS as well as course demographics and grades to assess student academic disparities related to course grades. The study's focus was to assess the academic impacts of being in a student-centered building by investigating academic outcomes in four different settings: 1) SCI course within the student-centered building 2) SCI course within a traditional building 3) didactic course within the student-centered building and 4) didactic course in a traditional building. I found no significant course grade differences within the four differing contexts. However, I did find, similar to K-12 literature, that class size is negatively related to course grades. Additionally, the physical science discipline was related to lower course grades. This may also be an indicator of differences in culture within the discipline.

Study 3

Through a semi-structured interview protocol and classroom observations, this study investigated the minoritized student perspective of SCI and what types of capital might they be able to utilize in the SCI context. I found that Latine students specifically discussed enjoying the ability to interact with students that had similar cultural backgrounds as them and the time to discuss the class topics in a way that is authentic to them using 'Spanglish' or other slang they were comfortable using when they were with other Latine students. Unlike the Latine students interviewed, the Southeast Asian students did not report anything similarly related to their cultural identity. However, both discussed the importance of instructor facilitation in SCI courses and being able to remember topics longer than solely for an exam and later having to reteach themselves.

Study Contributions

Together, these studies highlight some of the benefits of using SCI in STEM courses. Even though a multitude of studies provide evidence of SCI academic benefits (Eddy & Hogan, 2014; Freeman et al, 2014, Theobald, 2020), the other findings in my dissertation are what has really stood out. These include findings that relate to social support networks, diversity in the classroom, and the important of student perspective when studying higher education classrooms.

Importance of relationships and building a social network

Firstly, the significance of peer relationships in SCI courses highlights the opportunities SCI provides to create peer relationships. These peer social support networks are related to lower college attrition and higher GPAs (Dennis et al., 2005). As peer relationships are related to greater academic achievement, the study suggests that relationships have implications for longer term student success. Especially as students being given more opportunities to create relationships can lead for stronger social networks to navigate the higher education system, receive emotional support, and be able to seek guidance for job opportunities in the future.

Additionally, the relationship between being in a SCI course and an increase in self-efficacy shows students gain more confidence in themselves and the ability to be successful in STEM, which is related to higher STEM graduation (Ballen et al., 2017). Additionally creating these relationships with instructors is also important as an increase in instructor relationships opens opportunities for mentorship and undergraduate research which can be invaluable for applying to graduate school and finding job opportunities. As Study 1 shows, Latine students had significantly lower formal interactions with instructors. This highlights the importance for instructors to receive training on how to create more inclusive environments for students to feel comfortable interacting formally with instructors such as by encouraging students to attend office hours, taking time to write students emails for feedback, and encouraging questions to be asked. Both relationships can help students create social networks and support systems not only for STEM academic success, but to have post-graduation success as well.

Diversity and course demographics and its relationship with student success

The results from this study also suggest the importance of the learning environment and its relationship to student perspective in a STEM course. For example, the interaction relationship between the number of Latine students and being in a SCI course on test anxiety decreased test anxiety levels. This represents how beneficial creating diverse classrooms can be for students and contribute to moving towards creating inclusive learning environments. When courses have a class with students from different backgrounds, minoritized students are more likely to see and interact with others that they can relate and thus feel less isolated. As in Study 3, many of the students reported appreciating the ability to interact with peers like them and feeling as if they can also persevere and be successful.

Class enrollment was also negatively related to course grades which signifies that the larger course enrollment negatively impacts student performance. This directly aligns with previous research which discusses the negative impact large courses have on students. This finding shows a need for institutions to increase the amount of pedagogical training for instructors to be better able to apply differing teaching methods in large courses effective. This is especially relevant as how an instructor structures a course and facilitates activities made a difference for student learning. This emphasizes the need for clear expectations and strong instructor facilitation of evidence-based practices. Overall, these studies highlight that universities should consider the learning environments students will be placed in when considering how it may impact their STEM success.

Importance of student voice when exploring the student experience in SCI courses

Finally, students describing their experience in a student-centered course was invaluable. Students were able to describe which components of courses that use SCI were beneficial to them. Students reporting the importance of how an instructor structures the course and facilitates class activities represents how students know what may benefit their learning and their perspective is beneficial to understanding how we can create strong learning environments. This includes learning that Latine students were able to use social capital and linguistic capital to better master a course in a way that was authentic to them. Creating learning environments where students not only benefit academically, but also can create relationships with others and be confident they are able to thrive in STEM is essential to move towards more equitable learning environments.

Future Directions

Even though this dissertation has generated a wealth of knowledge, it has also culminated many new questions that I see my work heading towards in the future. Firstly, findings from Study 1 about the increase in peer relationships for students in SCI courses compels me to want to investigate how these relationships may persist over time. Thus, looking at some of the long-term implications of being in a SCI course would be of interest. These long-term outcomes would include STEM persistence, career trajectory, skills students feel they gained from their SCI courses versus their didactic courses, as well as what social support systems may have persisted over time and how did they relate to the experiences they had in college as a STEM student. I also would like to explore more about the different STEM discipline cultures and better understand the differences in course grades and behavioral outcomes that became apparent in the data. This would include how do different STEM discipline cultures differ and how does this impact students, particularly minoritized students. I would especially like to explore more of the Latine student perspective and better understand how we can create more inclusive learning environments within an HSI, within an PWI, and how this may look differently due to the nature and demographics of the university. Overall, despite the interesting results from this dissertation, this work is not nearly finished and extending the work to the above research projects can contribute to creating more inclusive learning environments where all students can thrive.

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