Summer 7-31-2023

Elucidating the Impacts of Learning Communities on Retention, Student Sense of Belonging, and Self-Efficacy in STEM

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ELUCIDATING THE IMPACTS OF LEARNING COMMUNITIES ON RETENTION, STUDENT SENSE OF BELONGING, AND SELF-EFFICACY IN STEM

By

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B.S. Chemistry
Dillard University, 2021

Submitted in Partial Fulfillment of the Requirements
For the Degree of Master of Science in the
Department of Chemistry and Biochemistry
Kennesaw State University
2023

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ABSTRACT

Student sense of belonging (SoB) and self-efficacy (SE) are necessary aspects of promoting achievement and success in the STEM fields. This study focuses on how learning communities affect students' SoB and SE in relation to STEM as well as demographics, including race, gender, and first-generation status. Students enrolled in either the introductory chemistry lecture or the first-year experience course (students grouped by similar STEM major) were asked to complete a STEM attributes survey (Likert scale) to assess their overall SoB to the university and their chosen major as well as their level of SE in relations to those fields. To predict each student's performance outcomes, our lab sought to analyze any changes in behavior and perception of overall success that may have occurred during the first semester of matriculation. This study also aimed to validate the use of the Belonging Survey and the SE Scale on small sized populations within a sample; in this case, learning communities. Among the 183 students surveyed, with 132 of them being enrolled in a learning community, we discovered that participation in a learning community indeed increased the likelihood of retention in one's chosen STEM field of study. Despite the fact that learning communities were found to statistically increase SoB for the University overall, there were no other statistical changes witnessed at the end of the first semester. Throughout the semester, students within the racial group of PER (persons excluded or misrepresented due to race) were found to experience a greater decrease in belonging in comparison to Historically Represented students (White or Asian) . Furthermore, learning community enrollment had a moderate impact on SE, with females

showing statistically lower levels of SE than males. Due to the small population size and limitations of time, future endeavors will involve gathering student feeling and perception in SoB and SE as it pertains to specific STEM fields such as Chemistry. In line with the literature, we believe that STEM identity and the development process also plays a major role in students' perception of inclusion and confidence in the STEM field. Our lab is interested in identifying and assigning STEM identity status memberships to students based on scoring in several key domains of learning. Findings linked with previous research studies demonstrate the importance of developing a manual method of assigning identity status memberships that corresponds to statistical outputs of identity membership assignments. We are still in the early stages of determining and understanding the exact practices that promote meaningful learning environments. Our goal is to comprehend specific practices that contribute to the study's findings and evaluate their overall impact.

ACKNOWLEDGEMENTS

This project was supported by the Department of Chemistry and Biochemistry at Kennesaw State University (KSU) on behalf of Dr. Michelle Head and the entire CSM First Year Experience Program.

During my matriculation here at KSU in pursuit of a Master's Degree in Chemical Sciences, I want to express my utmost gratitude to God, our Lord and Savior, for getting me through this research experience. To my committee members, Drs. Carl Saint-Louis and Kadian Callahan I am grateful for your extended support and guidance, beyond one can imagine. You have been a direct source of motivation, creativity, and structure whenever I called on them. To my Principal Investigator, Dr. Michelle Head, I am thankful for the effort and never-ending dedication you put into making our research goals attainable and molding me for life after KSU. Many thanks to my colleagues, especially Kirstin Goff, Sydney Diehl, Zeljka Zec, Keri Dowling, and Jessica Carter for keeping me grounded and supporting me through this experience.

Raegan and Amjad, the lab undergrads, are to be commended for providing everything we required for research and publication. Our success is a compilation of your efforts put forth and would not be achieved without you. Finally, I want to give a special thanks to my Mother, Father Figure, and Grandparents, Jennifer Williams, Irving Johnson, Mema, and Papa, respectively. Their words of encouragement, love, and financial support have made life easier and more worthwhile along the way. None of this would have been possible without you all. It is with you all that I stand firm in successfully achieving this dream of my own. Thank you.

CONTENTS

LIST OF ABBREVIATIONS

STEM	Science, Technology, Engineering, and Math
SoB	U/M-Sense of Belonging to University/Major
SE	Self- Efficacy
PER	Persons excluded or misrepresented
Hist. Rep.	Historically Represented, Race: White or Asian

LIST OF OPERATIONAL DEFINITIONS

Race: African American, White, Hispanic, Asian, Pacific Islander, and Hawaiian

Gender: Male, Female

First- Generation Status: First student in the immediate family to pursue a collegiate level education

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CHAPTER 1

LEARNING COMMUNITIES AND THE RELATIONSHIP BETWEEN SENSE OF BELONGING AND SELF-EFFICACY

This chapter reviews existing literature that drives the research behind this study. In general, this study seeks to uncover and bridge the gap between engagement in learning communities and students' overall sense of belonging (SoB) and self-efficacy (SE) as it relates to STEM. Additionally, this study aims to clarify the degree to which demographics, like race, gender, or first-generation status, affect students' first semester of study experiences. This study will examine in-depth learning communities, factors influencing both belonging and STEM SE in learning environments, and assess practices that either strengthen or weaken ones' personal belief.

1.1 Introduction

The most recent generations of students are enrolling into higher education science, technology, engineering, and math (STEM) programs at an increased rate.[1-3] Given the current problems faced globally such as disease prevention or environmental disparities, STEM education has become an important approach to address the problems that the workforce demands related to these areas.[4-6] The majority of academic disciplines at a collegiate level require or involve STEM to develop and refine competence overall. Historical events such as WWII or 9/11, in reference to the varying technologies and innovations implemented, results in the expansion of STEM education.[7] Organizations such as NASA use science and engineering to expand and improve research opportunities, complete missions, and offer STEM initiatives to engage students.[8] As the spectrum of STEM begins to broaden, STEM education suggests significant applications through classroom engagement,[9-11] commercial use,[12,13] conferences,[14] and presentations.[15,16] Students have opted to take courses at higher educational institutions in hopes to refine their academic skills through participation and engagement in varying STEM related activities and networking with other classmates.[17] These practices introduce the importance of smaller learning environments needed to foster student academic success and persistence in STEM disciplines.[17-19]

At large universities, students are particularly vulnerable within their first year of study, absent minded of the relevance, purpose, and importance of their collegiate experience and what's being taught.[20,21] Incoming students are still fresh with acquired ideas and behaviors from high school and/or pre-college instruction including study habits, communications styles, and interests.[20,22,23] Students are still early at indicating their true interests and finding purpose in pursuing their desired field of study.[24] As common pre-requisites for any STEM discipline, students must enroll in introductory STEM courses such as general chemistry or general biology before delving deeper into their major more. Many students struggle to learn topics in STEM, which deters them from the overall belief of success and achievement in STEM.[25-28] The motivation to learn and to explore STEM courses are fueled by students' perception of competence, expectancy of success, engagement strategies, personal values, and overall belief.[3,29,30]

Considering how students learn in undergraduate STEM environments is a key component in developing strategies to foster academic success in STEM. Collaborative and meaningful learning strategies incorporates the exchange of ideas amongst students and teachers, critical thinking, comprehension, and approach to subject matter.[31-33] Popular interventions include the implementation of STEM-based academic learning environments to promote comfort, motivation, and confidence in learning.[34,35] The idea of learning communities lies at the heart of higher education, focusing on themes relevant to a students' academic interests and overall success in STEM.

1.2 What is Known about Learning Communities

Learning communities are defined as smaller academic environments focused on a theme/topic relevant to a students' academic interest or personal characteristics.[35-37] Commonly at larger institutions, students are grouped into learning communities by their academic major, personality traits/characteristics such as being introverted or extroverted communicator, and/or educational level.[17] Students who participate in learning communities oftentimes take academic classes together, are provided activities to enhance their academic skills, and seek social and extracurricular activities together.[17,38] The overall purpose of learning communities is to develop and retain students in STEM disciplines at a higher rate to increase academic success, representation, and promote the pursuit of STEM careers upon graduation.[17] Learning communities have been found to predict academic performance, achievement, and persistence in STEM.[39,40] Due to its structure, learning communities are the foundation for social interactions between students, faculty, and STEM professionals. Studies show that participation in smaller learning communities promotes higher performance (GPA),[17,36,37] higher graduation rate,[17,40] participants report higher levels of academic self-efficacy,[36,46] and are overall more academically inclined in comparison to those not enrolled in a learning community.[35,37] Many students that are not enrolled in those nurturing learning environments are left unfulfilled due to the lack of experience and social interactions with peers.[17,47] Since learning communities are designed to promote peer-to-peer interactions, student collaboration and engagement is encouraged to think about complex topics and build a strong support system.[19,35,48] The benefits of learning communities generates interest in exploring other factors that contribute to making learning communities the best implementation to promote success, achievement, and commitment in the field of STEM.[17-19]

Participation in a learning community can provide students a space of inclusion and value which may not be felt while participating in other courses and activities.[37,49,50] Previous studies documented that first-generation students that participate in learning communities exhibit higher levels of engagement, better grades, and an increased retention rate. Other studies report increased involvement in academic activities and peer-based interactions outside of the classroom.[19,51,52] Some pieces of literature document that measuring students' social interactions, including perception of connectedness, support, and value enables the understanding of sense of belonging.[53,54] Learning communities have the potential to foster students' SoB as a key component of success in STEM and will be explored more in depth throughout this study.

1.3 STEM Retention

The trend of high failure in required coursework for STEM majors has caused retention rates in STEM to plummet as more students enroll in STEM-based courses.[28,35,55-57] Researchers have attempted to understand practices that influence performance, retention, belonging and confidence in STEM. Recruitment and retention of students in the field of STEM has been of concern, where STEM retention hovers at approximately 40% internationally.[35] STEM based disciplines are historically known for their rigor and high failure rate in the classroom.[58-60] Being a pre-requisite for many avenues in STEM, introductory courses such as general biology, general chemistry, or pre-calculus are offered during the first year of study. It is assumed and expected that students have acquired the knowledge and skills that will be applicable and transferable across discipline prior to enrolling.[61,62] Though students approach these courses with the intent to succeed, the unintentional feeling of discouragement causes a domino effect downhill.[35] There are several reasons undergraduate students feel the need to depart the field of STEM including: low performance,[63-65] lack of confidence,[66-68] fast-paced instruction and content overload,[35,37] improper teaching strategies,[69,70] loss of interest in STEM, [35] the competitive and unwelcoming culture of STEM,[71,72] and lack of representation in varying fields of STEM.[71,73-75] Data reports that approximately 27% of declared STEM majors reconsidered or changed their field of study within the first year of matriculation.[35] Disparities in STEM performance, achievement, and retention increase as the population of minority students continues to grow.[76,77] Further, low-income students may find participation and engagement far more difficult due to the lack of funding and support.[78,79] Studies have shown that due to the lack of diversity and confidence in the STEM field, PER find it more difficult to comprehend concepts that are presented and to build upon them in real-world settings.[71,80-83] These issues demand attention at institutional levels and highlight the importance of engaging learning environments to influence participation and positive performance in STEM.

1.4 Student Sense of Belonging

Sense of belonging (SoB) refers to the extent of which a student perceives connectedness, inclusion, and meaningful relationships within a group. SoB is linked with motivation and persistence, positively supporting students' engagement[84-86] and achievement in STEM.[87,88] Reiterating Maslow's Theory of Hierarchy of Needs, a student's basic SoB is motivated by emotions and self-esteem as it is related to a particular context.[45,89,90] Studies indicate that SoB influences both performance and retention across discipline in STEM.[90-94] Very few studies address how learning communities foster perception and enhance belonging to major and large institutional settings.[46,50] Studies suggest that belonging in STEM has significant impacts on educational success,[95-97] academic achievement,[89,94] retention,[57,96] persistence,[50,98,99] and commitment in STEM.[72,100] In past decades, SoB has been sought as a fundamental human need to interact and engage in different environments.[101] Peer-based interactions and interpersonal relationships (peer-to-peer/ peer-teacher) are critical factors in understanding student SoB in academic environments.[87] For example, peer-led discussions outside of the classroom was shown to increase the probability of women persisting in the field of STEM.[71,102] Other studies suggest that particularly, women of color are greatly influenced by peer interactions, relationships, and overall support.[71,102,103]

Within STEM, students from demographically marginalized groups are more susceptible to belonging uncertainty and report lower SoB than others more frequently.[89,90,97] Negative stereotypes formed against demographics such as race,[87,104,105] gender,[88,104,105] or first-generation status can predict performance and negatively impact student SoB.[50,106] External factors such as the lack of representation [72,105] or the competitive culture of STEM can influence ones' SoB.[50,71,107] According to research, women at larger institutions struggle struggle to maintain a positive SoB.[71,108,109] Other studies have shown that both women and students of color consistently report lower SoB than men and white students.[71,109,110] Persons excluded because of race or ethnicity (PERs), including both African American and Hispanic students, reported significantly lower feelings of inclusion than Whites (Historically Represented).[111] Gaps in literature include the lack of research on SoB pertaining to demographics at diverse institutions. Additionally, there is a lack of research linking diverse learning communities to overall participation in class and belonging.[112,113] Most of these studies are carried out at large, predominantly white institutions and don't have a significant amount of PERs across discipline to investigate. Studies produced about gender or race and overall SoB leave out the experiences and impacts faced by marginalized groups in STEM. This study aims to fill those gaps by investigating SoB to specified major and university and explore the demographic impacts, if any, faced within the first semester of study.

1.5 STEM Self-Efficacy

STEM Self-efficacy (SE) refers to the degree to which a person believes they can organize their thoughts, carry out a task, and accomplish a goal in the field of STEM.[114,115] SE is developed from self-perception and external experiences.[68] STEM SE is developed through interpreting outcomes of task experiences specific to STEM. SE is goal directed measuring the personal perception of confidence in attaining a specific goal. For example, STEM SE can be assessed by asking *"How confident are you in passing a STEM course at the end of the semester?"* or "How *confident are you in learning complex topics in STEM?"*. SE influences individualistic choices made, efforts to achieve goals, and predicts persistence and motivation.[115,116] It defines the level of which an individual believes they can successfully reach goals and navigate obstacles. Those that embody high SE believe that they can perform well at a given task and strive to achieve most tasks set forth to complete without distraction, while those exhibiting low SE may find it more difficult to master a task and tries to avoid obstacles.

Previous studies have compared the SE of men and women in STEM and the likelihood that they persist in the field, finding more negative correlations between women and SE.[117-120] More recent studies dispute the idea of gender difference in STEM SE, where SE is generally consistent for both.[121,122] Moreover, students exhibiting higher SE are shown to persist in their major at a higher rate than those with lower SE.[116,121,123] Wilson et al. (2015) investigated the linkage between emotional and behavioral engagement and belonging at an undergraduate level.[119] Results demonstrate the importance of SE in student engagement and the difference between SoB.[124] Gaps in literature include the absence of research on any demographic impacts on SE and what practices or experiences improve SE amongst college students. This study aims to address the gaps in literature by investigating how learning community impact on SE and if demographics such as race, gender, or first-generation status influence student SE within the first semester of study. Findings will enable the predictions of performance in STEM courses and the overall impact on long-term career plans in the field of STEM.

1.6 Goals of Current Study

Contrary to popular belief, student involvement and engagement are not valued equally in higher education.[125,126] Increasing STEM engagement requires developing and implementing academic and educational strategies to support student engagement, achievement, and commitment in STEM. To this extent, this study aims to explore the impacts that learning communities have on overall retention, student SoB, and self-reported confidence (STEM SE) within the first semester of study. These are common aspects students are challenged with as STEM majors and needs to be explored at a large institution. Comparisons within this study involve students enrolled in either the introductory course that introduces them to their specified major (learning communities) or students enrolled in introductory chemistry courses based on presence. Within those learning communities, this study aims to explore demographics impacts, if any, that influences belonging and SE as it pertains to STEM. Table 1 outlines the key questions that will guide this research study and will be answered throughout using hypothesis testing. Therefore, each null hypothesis is presented for each research question.

Table 1. Research questions of interests that guide the direction of study. Corresponding null and alternative hypotheses tested during data collection.

Research Questions	Null Hypothesis (H_0)
Are students enrolled in learning communities retained in their major through the first semester in college at a higher rate?	Students in a learning community are **not** retained in their major at a higher rate than those that are not in a learning community.
What is the overall impact of learning communities on S**ense of belonging**?	Learning communities have **no impact** on a student's sense of belonging.
What is the overall impact of learning communities on **Self-efficacy**?	Learning communities have **no impact** on a student's self-efficacy.
What is the overall impact of learning communities on a student's sense of belonging overall based on demographics?	A student's participation/performance in a learning community and race/ethnicity **does not** impact one's sense of belonging.
What is the overall impact of learning communities on a student's self-efficacy overall based on demographics?	A student's participation/performance in a learning community and race/ethnicity **does not** impact one's self-efficacy.

CHAPTER 2

DATA COLLECTION AND METHODOLOGY

This chapter introduces the instruments and methodology used to capture information about learning community impacts on sense of belonging (SoB) and self-efficacy (SE) during the first semester of study. Using a quantitative approach, this study statistically captured student perception and personal belief in the areas of belonging and SE as it pertains to their enrollment in a learning community and demographics such as gender, race, and first-generation status. SoB is defined as the feeling of acceptance and inclusion within a group, while SE is the individual perception of achievement and success at a given task. Learning communities are designed to group students by similar major (e.g. STEM majors), where students have similar academic schedules and seek to refine their academic skills through group-like engagement. A 39-question STEM Attributes survey was circulated to first-year students enrolled in either the three-credit hour introduction to major course or general chemistry 1 course during the fall semester of study. Qualitatively, we found that incorporating reflection prompts and open response survey questions allowed students more freedom in explanation that quantitative techniques fail to capture. Course enrollment data and other institutional information was captured during both periods of collection and used for demographic comparisons of data. The total number of participants who responded was 717 for the pre collection survey period and 510 for the post collection survey period. A total of 183 of the 1,277 completed both pre and post surveys and were included in statistical analysis. At the time of data collection, 132 of the 183 participants were enrolled in a learning community, compared to 51 who were not. Table 2 depicts the demographic composition of the student sample included in this study. There were 106 females and 77 males that participated in this study. Due to the lack of presence of students majoring in chemistry, the study shifted to look at students enrolled in STEM majors more broadly.

Table 2. Demographic composition of present study including both students enrolled and not enrolled in a learning community.

	LC Enrollment							
	YES				NO			
Race	PER		Historically Rep.		PER		Historically Rep.	
	Count	%	Count	%	Count	%	Count	%
	63	47.7%	69	52.3%	21	41.2%	30	58.8%
Gender	Male		Female		Male		Female	
	Count	%	Count	%	Count	%	Count	%
	48	36.4%	84	63.6%	29	56.9%	22	43.1%
1st Generation Status	Yes		No		Yes		No	
	Count	%	Count	%	Count	%	Count	%
	76	56.8%	56	42.4%	33	64.7%	18	35.3%

This study employs the use of validated instruments previously published in literature, such as the Belonging Survey and Self-Efficacy Measure to capture and understand the influencers of participation, engagement, and retention in STEM.[46,127] The previously published surveys were combined together into one survey that was given to the participants titled the STEM Attributes Survey. Instruments used throughout this study will be deemed reliable if the statistical outputs align with student response to the embedded open-response reliability questions within the survey and the previous findings of other studies. The methods in recruitment and the process of data cleaning prior to statistical analysis will be explained more in depth in the sections below.

2.1 Initial and Final Data Collection (Recruitment and Data Cleaning)

A two-part study was conducted during the fall semester of 2022 to measure student SoB and SE and compare experiences based on learning community enrollment and demographics. To recruit students for participation in the study, General Chemistry I professors in the Department of Chemistry and Biochemistry and instructors of the introductory to majors course were asked to circulate a QR code linking students to the STEM attributes survey. In addition, instructors had the option to invite in a researcher to share information about the research study, recruit participants, and in some cases have students complete the survey while being present. In September 2022 during the first semester, students were given 25 minutes of class-time to complete the survey and awarded bonus points at the professor's discretion as an incentive for participation in the study. The survey was paused at the end of the pre collection period, shutting off opportunity for participation and finalizing respondents. Obtained results were cleaned prior to statistical export and analysis along the following criteria:

1. Consent for participation in the study
2. 18 years of age or older
3. Completion of the entire survey

4. Removal of those who improperly responded to the embedded validation questions
5. Corresponding institutional data (no nicknames, students enrolled in correct course level at time of collection)

Following the collection period, open response questions were reviewed and revised to capture information that was not embedded in survey questions, allowing students more freedom in their response. An example question is as follows: *"What contributes to your confidence, or lack of confidence, when explaining science or math concepts to your peers?"*. During November of 2022, the survey was circulated again via QR code and in-person collection. The same steps listed above were used to clean the post data set where participants were removed if they did not participate in both pre and post collection periods. This sample is composed of 183 students. Upon review, both pre and post data was compiled into one excel workbook and imported into IBM SPSS statistical software for quantitative analysis.

2.2 Instrumentation

2.2.a Sense of Belonging Survey

The Sense of Belonging (SoB) Survey is an 11-question instrument designed to assess the extent of which a student feels they belong in a group, in this case, at the university and in their specified major.[46] Students were provided a 5-point Likert scale in which they were to rate the extent of which they agree to each statement: *1=strongly disagree, 2-disagree, 3=neutral, 4=agree, and 5=strongly agree*. Example prompts for both sense of belonging to university and major are included below in Table 3.

Table 3. Sense of Belonging Survey questions and scoring.

Question	Likert Scale
Sense of Belonging to University	
"I feel that I am a member of my university's community."	1= "strongly disagree" 3= "neutral" 5= "strongly agree"
"I feel comfortable on my campus."	
Sense of Belonging to Major	
"If given the opportunity, I would choose my academic major again."	1= "strongly disagree" 3= "neutral" 5= "strongly agree"
"I feel a sense of belonging to my academic major's community."	

2.2.b Self -Efficacy Measure

Self-efficacy (SE) is defined as the extent at which one believes in their ability to complete a task or succeed.[115] Outside influences, making choices, and behavioral shifts are key components in understanding SE. Researchers were interested in understanding the extent at which teaching and learning strategies impact literacy for non-biology/ non-STEM majors.[128] An instrument was designed to capture a students' self-reported confidence in understanding and application in daily life.[127] Generated results allowed interpreters to understand student behaviors that shaped interests and promoted comprehension and success in a specified field of study or profession. For the present study, this instrument was sufficient in indicating confidence levels as students engage and participate in courses and varying activities within their major or learning community.

Students were asked to respond to the SE Measure embedded into the survey during both pre and post collection periods.[127] This five-question instrument was designed to capture a students' self-reported confidence on a five-point Likert scale upon participation in their specified field of study or learning community. Table 4 includes sample prompts given to students on the survey.

Table 4. Self-Efficacy Measure survey questions and scoring.

Questions	Scoring: 5 pt. Likert Scale
I am certain I can master the skills taught in STEM classes this year." "I can do almost all the work in my STEM classes if I don't give up." "Even if the work in STEM is hard, I can learn it."	1= "strongly disagree" 3= "neutral" 5= "strongly agree"

2.3 Quantitative Methods of Analysis

All analyses were completed using the calculated Gain score for each category. Gain is defined as the difference between instrument-based scoring on two or more occasions, in this case pre and post collection periods. Gain scoring allows interpreters to draw conclusions about the change in attitude, behavior, or feeling over the duration of sampling, in this study, a semester.

$$\text{Normal Gain} = (\text{post score} - \text{pre score})/100 - (\text{pre score}) \qquad \textbf{(eq. 1)}$$

A file compiled with all the data from each survey was imported into the IBM SPSS Statistical software for analysis. The Belonging Survey was coded accordingly: 1 representing *strongly disagree*, 2 representing *disagree*, 3 representing *neutral*, 4 representing *agree*, and 5 representing *strongly agree*. Scores were grouped by SoB to University (SoB_U) or Major (SoB_M) and analyzed separately. The SE measure was coded accordingly: 1 representing *strongly disagree*, 2 representing *disagree*, 3 representing *neutral*, 4 representing *agree*, and 5 representing *strongly agree.* Each construct was explored using the descriptive features embedded in the software. In this study, students who racially identified themselves as African American, Pacific Islander, Hispanic, or Hawaiian were grouped as PERs while Whites and Asians were grouped as Historically Represented students, in accordance to literature.

Understanding the distributions within a population of interest allows interpreters to determine the most efficient statistical test to run based on trends in data. A Kolmogorov-Smirnov Test of normality was conducted as the first step in statistical analysis, determining if non-parametric testing was necessary. The output of larger p-values ($p > 0.05$) is indicative of the data set following a normal distribution, hence accepting the null hypothesis. The output of values $p < 0.05$ does not follow normal distributions in which we reject the hypothesis at hand. Since this study focuses on different subsets of the population, definite p-values will not be reported. Data sets that do not follow normal distributions underwent non-parametric analysis to determine if sample means were significant or not.

Table 5 illustrates the quantitative analysis techniques used to analyze each research aim throughout this study. The *Chi-Square Test of Association* was used to determine the relationships between categorical variables. Examples from the present study include the demographic comparisons of the relationship between learning community enrollment and retention in specified major or the comparison of overall impact of learning communities between gender. Due to the non-parametric nature of the variables (determined by test of normality), a *Mann-Whitney U* test was performed to determine significance between learning community enrollment and scoring in SoB and SE. The Mann Whitney- U statistic and asymptotic p-values indicates the nature of significance of our sample, allowing interpreters to draw conclusions about the population of interest. This test was used to compare students enrolled in a learning community to those who were not enrolled in the categories of Sense of belonging to the university, major, and STEM self-efficacy. The test was also used to compare the mean scores of SoB_U, SoB_M, and SE relative to demographic comparisons in gender, race group (PER vs. Historically rep.), and first-generation status for those enrolled in a learning community. Together, these tests were used to determine the impacts and overall significance of learning community enrollment on retention, SoB to the university, SoB to specified major, and STEM SE.

Table 5. Guiding research topics and corresponding quantitative analysis techniques.

Specific Aims	**Analysis Method**
Evaluate how participation in a learning community effects retention overall in major and at university.	Descriptive Statistics Chi Square Test of Association
Evaluate retention rates between demographic groups in STEM based on learning community enrollment.	Descriptive Statistics Chi Square Test of Association
Evaluate the impacts of learning communities on SoB and STEM SE within the first semester of study.	Descriptive Statistics Mann Whitney U Test
Evaluate the extent at which demographic groups in STEM develop a greater SoB and STEM SE while enrolled in a learning community.	Descriptive Statistics Mann Whitney U

2.4 Establishing Validity and Reliability

To establish the validity and reliability of the identified instruments, students were asked questions to ensure the survey was consistently capturing and measuring student SoB and SE. The validation of instruments was achieved by embedding two validity questions, one within each individual the survey, requesting students to provide a specific ranking on the Likert-scale. Students who did not respond with the correct ranking were removed from the data set as it demonstrated they were not reading thoroughly and therefore, may not provide valid answers to other prompts provided. Reliability was established using the open response questions embedded within the survey in comparison to scoring in each construct (SoB, SE). Responses were reviewed and holistically coded using deductive coding strategies to define responses prior to statistical analysis. Table 6 displays the thematic coding techniques used to understand answers to open response questions and reflection pieces. For example, the question *"What contributes to your confidence, or lack of confidence, when explaining math or science concepts to your peers?"* corresponds to the measure of SE, capturing student perception of confidence in STEM. Responses were ranked *high* or *low* based on extent of alignment to the overall theme (SoB or SE). The results of the reliability of each instrument will be discussed more in depth in a later section.

Table 6. Qualitative coding of open response and reflection prompts.

Category/Construct	Sense of Belonging	Self-Efficacy
Question	Which aspects of your service-learning community made belonging to your major meaningful and why?	What contributes to your confidence, or lack of confidence, when explaining science or math concepts to your peers.
Example Statement Rank: High=5	I found great value in the service-learning aspect of this class. It has helped me have a better understanding of the class and what this class is about.	I feel teaching someone other things bring up my confidence because I have to truly understand the subject to explain it.
Example Statement Rank: Low=1	They were no aspects that made me feel as if I belong in my major. I feel the same about my major as when this semester started.	I lack core motivation and drive a lot of times when trying to learn the information being taught in my classes which makes doing well difficult

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Impact of Learning Communities on Retention

A Chi-Square Test of Association was used to determine the relationship, if any, between learning community enrollment and major retention within the first semester of study (Table 7). The portion of students who were enrolled in a learning community and retained within their major is 90.2% (119 students) of the total 132 students that were enrolled overall. It was found that students enrolled in learning communities were not statistically more likely to be retained than those who are not enrolled in a learning community. The number of students who were retained within their major and were enrolled in a learning community was 119, which was greater than the number of students who were retained but not enrolled in a learning community, which was 47. As shown in the table, the Phi and Cramer's V statistics demonstrate a weak association between learning community enrollment and retention. Table 7 shows that learning communities have no statistically significant effects on major retention within the first semester of college.

Table 7. The impact of learning community enrollment on major retention

	LC Enrollment			
Major Change	**Yes**		**No**	
	Count	% in LC	Count	% in LC
Retained in Major	119	90.2%	47	92.2%
Not Retained in Major	13	9.8%	4	7.8%
Phi Value	.031			
Cramer's V	.031			
Chi Square	X(1)=0.176, *p*=>0.05			

3.1.a Impact of Learning Communities on Retention based on Demographics

Of the 184 students surveyed, we conducted demographic comparisons of retention between students enrolled in a learning community and those who were not. Tables 8, 9, and 10 illustrate the comparisons between learning community enrollment and demographics including gender, race, and first-generation status. A Chi-Square Test of Association was conducted to determine impacts of learning community enrollment and gender on retention at the end of the first semester. In table 8, gender is shown to statistically impact retention while enrolled in a learning community (p=<0.05). Males were retained at a lower rate in comparison to females for those enrolled in learning communities. For students not enrolled in a learning community, males were retained at a statistically lower rate in comparison to females. Indicated by a Cramer's value of 0.233, we can conclude that gender and learning community enrollment have a medium association with retention overall. For students not enrolled in a learning community, there is no statistical difference among the retention of males and females in their major. Overall, it can be concluded learning community enrollment positively impacts retention based on gender.

Table 8. Impact of learning community enrollment on retention based on gender.

	LC Enrollment							
	YES				**NO**			
	Gender				Gender			
	Male		**Female**		**Male**		**Female**	
	Count	%	Count	%	Count	%	Count	%
Retained in Major	46	95.8%	73	86.9%	27	93.1%	20	90.9%
Retained at University (major changers)	0	0.00%	10	11.9%	1	3.4%	1	3.4%
Unenrolled	2	4.2%	1	1.2%	1	3.4%	1	3.4%
Phi Value	**0.233**				0.040			
Cramer's V	**0.233**				0.040			
Chi Square	**X(2)=7.175, p=<0.05**				X(2)=0.083, p=>0.05			

***BOLD** numbers indicate statistical significance

Table 9 illustrates the impacts learning community enrollment has on retention based on race. As described in earlier sections, persons excluded because of race or ethnicity (PERs) are of interest since previous literature highlights the unfulfilling experiences endured during matriculation. A Chi-Square Test of Association was conducted to compare retention rates based on learning community enrollment and race grouping. For students that were not enrolled in a learning community, students within the PER category were retained at a statistically higher rate. In a holistic comparison to those who were enrolled in a learning community, both PERs and historically represented students were retained at a consistent rate amongst both groups. Oddly, historically represented students who were not enrolled in a learning community were retained at a statistically higher rate than the historically represented students who were enrolled in a learning community. Since values were not high enough to bear statistical significance, we can conclude that learning community enrollment had no significant impact on retention based on race.

Table 9. Impact of learning community enrollment on retention based on race (PER vs. Historically Rep.).

	LC Enrollment							
	YES				**NO**			
	PER		**Historically Rep.**		**PER**		**Historically Rep.**	
	Count	%	Count	%	Count	%	Count	%
Retained in Major	57	90.5%	62	89.9%	20	95.2%	27	90.0%
Retained at University (major changers)	4	6.3%	6	8.7%	1	4.8%	1	3.3%
Unenrolled	2	3.2%	1	1.4%	0	0.0%	2	6.7%
Phi Value	0.071				0.172			
Cramer's V	0.071				0.172			
Chi Square	X(2)=0.672, p=>0.05				X(2)=1.501, p=>0.05			

Table 10 illustrates the impacts learning community enrollment on retention based on first-generation status. As defined in earlier sections, first-generation college students are those who are the first in their immediate family to pursue a secondary education. First-generation students were retained at a higher rate when they were not enrolled in a learning community. Non-first-generation students who did not participate in a learning community were consistent in the dynamic of retention as other groups surveyed. First-generation status and learning community bear no significant associations and does not significantly impact retention of first-generation students within the first semester of study.

Table 10. Impact of learning community enrollment on retention based on first-generation status.

	LC Enrollment							
	YES				**NO**			
	First-Generation Status				First-Generation Status			
	Yes		**No**		**Yes**		**No**	
	Count	%	Count	%	Count	%	Count	%
Retained in Major	67	89.3%	51	91.1%	31	93.9%	16	88.9%
Retained at University (major changers)	7	9.3%	3	5.4%	1	3.0%	1	3.0%
Unenrolled	1	1.3%	2	3.6%	1	3.0%	1	3.0%
Phi Value	0.102				0.090			
Cramer's V	0.102				0.090			
Chi Square	X(2)= 1.376, p=>0.05				X(2)=0.411, p=>0.05			

3.2 Impact of Learning Communities on Sense of Belonging

As defined in earlier sections, SoB is the personal perception of inclusion and value within a group or large environment. Scoring in the SoB portions of the survey (SoB_U and SoB_M) were used in understanding and determining the effects, if any, learning communities had on SoB to both the university and an academic major/group. Tables 11 and 12 highlight the impacts learning community enrollment had on student perception of inclusion throughout the semester.

3.2.a Sense of Belonging to University

Kolmogorov-Smirnov testing for normality was used to determine whether the distributions within our sample for Sense of Belonging to the University (SoB_U) was normal. SoB_U was found to be normally distributed for both the students who were and were not enrolled in a learning community. A Mann-Whitney U test was conducted to compare the differences between learning community enrollment and scoring in the SoB_U portion of the survey. Further, those enrolled in a learning community exhibited a statistically greater SoB to the university, indicated by the bold font in Table 11. From this data, we can infer than learning community enrollment promotes a greater sense of belonging to the university.

Table 11. Impact of learning community enrollment on Sense of Belonging to University.

Construct	SoB_U	
LC Enrollment	YES	NO
Count (#)	132	52
Mean	**0.0084**	**-0.0359**
Std. Dev.	0.06684	0.07971
Kolmogorov-Smirnov Test of Normality	0.073	0.103
Significance of KS test	0.084	0.200
Mann-Whitney U	U=2172, **p=<0.001**	

***BOLD** numbers indicate statistical significance

3.2.b Sense of Belonging to Major

A Kolmogorov-Smirnov test for normality determined that the distributions within our sample for SoB to specified major (SoB_M) were not normal. Therefore, a Mann-Whitney U test was conducted to compare the differences between learning community enrollment and scoring in the SoB_M portion of the survey. Learning community enrollment promoted a statistically greater SoB to major (p=<0.05). Students that were not enrolled in a learning community were observed to have a decrease in their SoB_M compared to the students enrolled in a learning community, who had a slight increase over the course of the semester. From this, it can be concluded that learning community enrollment has a significant impact on SoB to a specified major or smaller academic group. This data drives interest in understanding the specific aspects and practices in learning communities that enhance student perception of inclusion (SoB). Further, it would be interesting to explore the relationship between sense of belonging to major (SoB_M) and course performance within the first year of matriculation to understand if these spaces of inclusion and value promote achievement and success in the field of STEM.

Table 12. Impact of learning community enrollment on Sense of Belonging to specified major.

Construct	SoB_M	
LC Enrollment	YES	NO
Count (#)	132	52
Mean	**0.0036**	**-0.0236**
Std. Dev.	0.06499	0.07601
Kolmogorov-Smirnov Test of Normality	0.083	0.102
Significance of KS test	**0.025**	0.200
Mann-Whitney U	U=2766.5, **p=<0.05**	

***BOLD** numbers indicate statistical significance

3.3 Impact of Learning Communities on STEM Self-Efficacy

As defined in earlier sections, STEM SE is the extent at which a student perceives they can complete a task or achieve/succeed in STEM. Students exhibited a slight decrease in SE for those who were not enrolled in a learning community, Table 13. In the comparison of means, Table 13, there was no significant difference exhibited. There were no other statistical differences found in SE as it pertains to learning community enrollment. In future studies, it would be helpful to have a larger sample size to accurately measure and identify shifts in perception overtime. Since STEM-SE is a measure of confidence, it would be interesting to explore aspects of learning communities that contribute and enhance confidence in STEM overall. Comparisons can be used to predict performance and the probability of pursuing a career in the field of STEM.

Table 13. Impact of learning community enrollment on STEM Self-Efficacy.

Construct	**STEM- SE**	
LC Enrollment	YES	NO
Count (#)	132	52
Mean	**0.0004**	**-0.0049**
Std. Dev.	0.06194	0.05988
Kolmogorov-Smirnov Test of Normality	.111	.101
Significance of KS test	**<0.001**	0.200
Mann-Whitney U	U=3311.5, p=>0.05	

***BOLD** numbers indicate statistical significance

3.4 Impact of Learning Communities on Sense of Belonging and Self-Efficacy based on Demographics

This study extends the use of the Belonging Survey and the SE Scale as validated instruments to measure collegiate level SoB and SE at a large university as it pertains to demographics. This study investigates the extent of which demographics such as gender, race, and first-generation status effects students' SoB and SE while enrolled in a learning community. We analyzed responses from a subset of our population, including the 132 students who were enrolled in a learning community during their first semester of study. Of those 132 students, 48 students were male and 84 were female, 63 students were classified as PER while 69 were Historically Represented, and 75 students were first-generation college students while other 56 were not. It was imperative to consolidate racial categories due to the small numbers of students when divided by race.

3.4.a Learning Community Impact on Sense of Belonging to University based on Demographics

First, we report the differences in SoB to the university by gender, race group, and first-generation status for students enrolled in a learning community (Tables 14,15, and 16). As shown Table 14, both males and females exhibited similar levels of SoB to the university over the course of the first semester. From this, it can be concluded that gender had no impact on sense of belonging to the university while being enrolled in a learning community during the first semester of study.

Table 14. Impact of learning community enrollment on SoB to the University based on gender.

	Gender			
	Male		**Female**	
	Count	**% Enrolled**	**Count**	**% Enrolled**
	48	36.4%	84	63.6%
Mean	0.0066		0.0094	
Std.	0.05769		0.07186	
KS Test Normality	0.200		0.200	
Mann Whitney U	(U=1944, p=>0.05)			

Interestingly, both race groups (PER vs. historically represented) experienced an increase in SoB to the university, though PERs experienced less of an increase in belonging by the end of the semester (mean scores 0.0028 vs. 0.0134, respectively), as shown in Table 15. It is important to note that the historically represented race group (White and Asian) gained a SoB to the university during the semester.

Table 15. Impact of learning community enrollment on SoB to the University based on race groups (PER vs. Historically Rep.).

	Race Group			
	PER		Historically Rep.	
	Count	**% Enrolled**	**Count**	**% Enrolled**
	63	47.7%	69	52.3%
Mean	**0.0028**		**0.0134**	
Std.	0.07473		0.05882	
KS Test Normality	0.200		0.193	
Mann Whitney U	(U=1954.5, p=>0.05)			

As shown in Table 16, a students' SoB to the university increased over the course of the semester while being enrolled in a learning regardless of first-generation status. However, there were no significant differences observed between the two groups.

Table 16. Impact of learning community enrollment on SoB to University based on first-generation status.

	1st Generation Status			
	Yes		No	
	Count	**% Enrolled**	**Count**	**% Enrolled**
	75	57.3%	56	42.7%
Mean	0.0075		0.0082	
Std.	0.06738		0.06660	
KS Test Normality	0.200		0.200	
Mann Whitney U	(U=2044, p=>0.05)			

3.4.b Learning Community Impact on Sense of Belonging to Major based on Demographics

SoB to a specified STEM major (SoB_M) by gender, race, and first-generation status for students enrolled in a learning community are reported in Tables 17, 18, and 19.

In opposition to previously conducted studies, gender did not significantly differentiate the impacts learning communities had on SoB to major with the first semester of study (Table 17). Both males and females increased their perception of belonging to their major from the beginning of the semester to the end.

Table 17. Impact of learning community enrollment on SoB to specified major based on gender.

	Gender			
	Male		**Female**	
	Count	**% Enrolled**	**Count**	**% Enrolled**
	48	36.4%	84	63.6%
Mean	0.0056		0.0024	
Std.	0.05509		0.07031	
KS Test Normality	0.200		0.200	
Mann Whitney U	(U=1951.5, p=>0.05)			

Upon grouping students by race within the categories of either PER (commonly misrepresented in STEM because of race) or historically represented (White or Asian) as explained in earlier sections, it was found that race had a greater impact on student SoB to specified major than any other demographic investigated (U=1718.5, p=.038). Table 18 highlights the statistically greater impacts learning community enrollment had on student SoB_M within the historically represented race group during the first semester of matriculation.

Table 18. Impact of learning community enrollment on SoB to specified major based on race groups.

	Race Group			
	PER		**Historically Rep.**	
	Count	**% Enrolled**	**Count**	**% Enrolled**
	63	47.7%	69	52.3%
Mean	-0.0083		0.0144	
Std.	0.07374		0.05411	
KS Test Normality	0.200		0.200	
Mann Whitney U	(U=1718.5, p=<0.05)			

Table 19 illustrates the results of first-generation status on student SoB_M within the first semester of study, where those who were not first-generation students were abnormally distributed within the sample (*p*=< 0.05). From this, we could infer that students who are not first-generation students have a statistically greater SoB to their major while being enrolled in a learning community.

Table 19. Impact of learning community enrollment on SoB to specified major based on first-generation status.

	1st Generation Status			
	Yes		**No**	
LC Enroll	**Count**	**% Enrolled**	**Count**	**% Enrolled**
YES	75	57.3%	56	42.7%
Mean	-0.0021		0.0112	
Std.	0.07218		0.05427	
KS Test Normality	0.200		**0.016**	
Mann Whitney U	(U=1882, p=>0.05)			

From the data illustrated in Tables 17, 18, and 19, race had more of a significant impact on student SoB to specified major (SoB_M) in comparison to gender and first-generation status while being enrolled in a learning community.

3.4.c Learning Community Impact on STEM Self-Efficacy based on Demographics

Lastly, we report the differences in student STEM self-efficacy (STEM-SE) by gender, race group, and first-generation status while enrolled in a learning community (Tables 20, 21, and 22). Results are indicative of the significant relationships between enrollment in a learning community and the perception of confidence within females, historically represented, and first-generation students within the first semester of study. As described in Table 20, females were found to have lower STEM- SE while being enrolled in a learning community, though not statistically significant. This is contrary to previous suggestions of the unbiased perception of STEM-SE between males and females.

Table 20. Impact of learning community enrollment on STEM-SE based on gender.

	Gender			
	Male		Female	
	Count	% Enrolled	Count	% Enrolled
	48	36.4%	84	63.6%
Mean	0.0036		-0.0014	
Std.	0.05762		0.06455	
KS Test Normality	0.200		0.007	
Mann Whitney U	(U=1958.5, p=>0.05)			

Though the results for students within the historically represented race group were found to be abnormally distributed (p= 0.018), there was no significant difference between the two groups (Table 21). Historically represented students displayed higher levels of STEM-SE at the end of the first semester in comparison to PERs, though not statistically significant. From this, we could infer that the practices within learning communities impacting STEM-SE needs to be explored more in depth from a racial standpoint.

Table 21. Impact of learning community enrollment on STEM-SE based on race group.

	Race Group			
	PER		Historically Rep.	
	Count	% Enrolled	Count	% Enrolled
	63	47.7%	69	52.3%
Mean	0.0001		0.0007	
Std.	0.06815		0.05619	
KS Test Normality	0.079		0.018	
Mann Whitney U	(U=2161, p=>0.05)			

Moreover, first-generation students were found to have a lower, although not statistically significant, STEM-SE than those who were not first-generation students while being enrolled in a learning community (Table 22), though it was not statistically significant. Those who were not first-generation students appeared to exhibit a higher STEM-SE at the end of the first semester. From this data, we can infer that learning community enrollment moderately affects the perception of confidence and achievement in the field of STEM (STEM-SE).

Table 22. Impact of learning community enrollment on STEM-SE based on first-generation status.

	1st Generation Status			
	Yes		No	
	Count	% Enrolled	Count	% Enrolled
	75	57.3%	56	42.7%
Mean	-0.0032		0.0050	
Std.	0.06639		0.05627	
KS Test Normality	<0.001		0.200	
Mann Whitney U	(U=2037, p=>0.05)			

3.5 Establishing the Reliability of Instruments

This study is focused on the impacts learning communities had on overall SoB and STEM SE at a large university within the first semester. The primary goal was to gather enough information to understand and predict student experience and perception regarding their major, career goals, and trajectory of matriculation while studying areas in STEM. In development of the STEM Attributes Survey used for the collection of data pertinent to this study, the validation of the instruments was achieved be embedding validity questions within the survey in which students were asked to respond in a specific way. Those who responded incorrectly were removed from the data set. Reliability was established using both open response questions and reflection prompts, assessing the alignment between student response and scoring in each category of the survey (SoB and STEM-SE). To determine the accuracy in measure of each instrument, responses were coded based on the extent of perception expressed in comparison to defined examples of *high* or *low* belonging and SE in STEM.

Tables 23 and 24 illustrate the process of establishing reliability for both instruments. The validation of the Belonging survey was achieved by asking students *"Which aspects of your service-learning community made belonging to your major meaningful and why?"* (Table 23). The highest possible score for this instrument, as described earlier, was 25 total utilizing a 5-point Likert scale. The lowest possible score was a total of 5 where the cut-off point between high or low SoB was determined to be 15 points, indicating a clear difference in perception. Of the 20 students/responses selected at random, there was an 80% match rate insinuating the reliability of the selected instrument accurately measuring the population of interest. Table 24 highlights the validation of the SE scale, where there was an 85% match rate between student response and scoring, insinuating the reliability of this instrument as well.

Table 23. Establishing the reliability of the use of the SoB Survey using embedded validation question from the survey. Open responses were compared to scoring in the category of SoB_M.

Question: "Which aspects of your service-learning community made belonging to your major meaningful and why?"

Student	**Response**	**Sense Of Belonging Survey Scoring:** SoB_M
	High SoB	
Student 1	"My major is Biology so incorporating science into my learning, has made me value the work that I am required to do."	20
Student 2	"I found great value in the service-learning aspect of this class. It has helped me have a better understanding of the class and what this class is about."	17
	Low SoB	
Student 3	"I would say I value doing the work for my other courses, mainly because the other courses are the backbone of my major and are going to be expanded upon rather than, for example, doing research on SDGs. I did value doing activities in my learning community, it opened my eyes to global problems and gave me insight on conducting research and the aspects of research. however, in comparison to conducting research, versus expanding my understanding of science and mathematics, I value the latter more."	12
Student 4	"They were no aspects that made me feel as if I belong in my major. I feel the same about my major as when this semester started."	13

Table 24. Establishing the reliability of the use of the SE_M using embedded validation questions from the survey. Open-responses were used in comparison to scoring in the category of SE.

Question: "What contributes to your confidence, or lack of confidence, when explaining science or math concepts to your peers?"		
Student	**Response**	**S.E Scale Score**
	High SE	
Student 1	Just the will to not give up and the mindset of giving this my all and staying headstrong.	19
Student 2	I have always had a natural understanding of the science and math areas. I am a very logical/problem solving thinker which helps me to actively work through STEM topics without much planning or contemplating.	25
	Low SOB	
Student 3	"Trying my hardest and still not doing well makes me less confident and want to look into other jobs."	15
Student 4	"I just feel like I do not have a well enough grasp. I am not proficient in math at all, and a lot of science courses are very hard for me because I did not take them in high school due to my previous career path being in Theatre Management. I feel like I am so behind the curve of everything STEM related and I constantly feel like I am the most ill-informed and ill-knowledgable person in all of my classes."	12

CHAPTER 4

CONCLUSIONS, IMPLICATIONS, AND FUTURE ENDEAVORS

Learning communities are key components in promoting meaningful learning environments for students to comfortably navigate higher education in STEM. STEM based learning communities can be used as mechanisms to introduce students to the various avenues in STEM and enhance student academic performance, foster success, and increase the probability of commitment to the field of STEM. The purpose of this study is to explore the extent at which learning communities promote effective environments for student learning, impact sense of belonging (SoB) and self-efficacy (SE), and if demographics such as gender, race, or first-generation status impacted student experience within the first semester of study. Overall, we found that learning communities decrease academic gaps across discipline. Our findings indicate that males were retained in their major at a higher rate. Interestingly, of the students enrolled in a learning community, males were retained at a statistically higher rate in comparison to those enrolled, though it was not statistically significant. For students that were not enrolled in a learning community, PER students were retained at a statistically higher rate. Moreover, first-generation status does not significantly impact retention within the first semester of study. Contrary to literature, where learning communities should create a space or inclusion, we found that the current teaching practices do not statistically contribute to an increase of retention among students who were often marginalized. [49,83,129] We can infer that learning community enrollment increases the probability of retention overall while race and gender impact the probability of retention after the first semester of study.

The overall presence of SoB and SE in STEM differentiates the trajectory of matriculation for students at a collegiate level. Learning communities have the potential to enhance different aspects of learning including student perception of inclusion or overall confidence in STEM (SoB and SE). In investigating the extent of which learning community enrollment effects SoB to the university and a specified major, we found that students who were enrolled in a learning community exhibited a statistically greater SoB to the university and their specified major. On the other hand, students that were not enrolled in a learning community were found to have a large decrease in their STEM-SE over the course of the first semester. From this, it would be interesting to explore the different types of learning communities and the specific practices that promote an increase in feeling.

Regarding gender, color, or first-generation status, there was no evidence to support the positive effects learning communities have on student SoB to the university as it pertains to gender, race, or firs-generation status. In alignment with literature, students from underrepresented groups in STEM exhibit statistically lower perceptions of belonging in STEM-based academic environments.[57,71,109,130] Additionally, it was found that participation in learning communities reduced students' perceptions of their competence and success in STEM (STEM-SE). The varying aspects and practices that diminish feeling of value, meaning, and confidence in diverse STEM environments should be explored more in depth in future studies.

Nonetheless, this study had several limitations and should be considered in future studies. There was a relatively small sample size (183 students), a lack of presence in students majoring in chemistry, and a small window of time for data collection. Given the limited number of students surveyed, we were not able to fully conclude on student perception as it pertains to learning community enrollment or demographics. Further, the contents of the learning communities were not explored in depth, therefore the specific practices and aspects that contribute to student experience and overall success cannot be identified. Future endeavors consist of analyzing a larger sample size to draw accurate conclusions about the population of interest. Further, we believe that SoB and SE in STEM are leading predictors of STEM Professional Identity development in students. STEM identity is the extent at which a student feels alignment with a theme/field in STEM or perceives themselves as someone who is or will be a STEM professional. We are interested in measuring STEM identity and the practices that constitute specific identity statuses to understand and differentiate student experiences that contribute to changes in development. A growing body of research demonstrates that learning communities increase student engagement and retention in STEM courses. In conjunction with the findings of this study, we intend to investigate the nature of students who do not persist in the field of STEM and provide intentional meaningful learning spaces for students to succeed. We hope that our efforts will be considered strong enough to influence teaching practices in introductory level STEM courses and learning communities across disciplines in order to promote academically nurturing environments for all students and to create approaches to future works that test the insights of this study.

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