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Impact of a STEM Living Learning Community on First-Year Science and Technology Students' Success at a Historically Black College and University

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Student retention and lack of encouragement are post-secondary institutional barriers that play a critical part in why African Americans are represented in small numbers in science, technology, engineering, and math (STEM) (National Science Foundation, 2017). Historically Black Colleges and Universities (HBCUs) have always promoted a supportive learning atmosphere for African American students. Living learning communities (LLC) were created to improve academic outcomes and to encourage social engagement. The findings of this study suggest that an LLC at an HBCU plays an integral role in sustaining programmatic retention of STEM majors and improving the academic as well as in social outcomes of first-year science and technology students.

African Americans who attend Historically Black Colleges and Universities (HBCUs) graduate the most students in STEM compared to their counterparts at a Predominately White Institution (PWI). HBCUs graduate 27% of African Americans with undergraduate STEM degrees (National Center for Education Statistics, 2019). This percentage is considered low when compared to graduates of different racial backgrounds. Contributions to the lack of or underrepresentation of African American students in STEM are primarily due to issues related to attrition, campus diversity, and financial disadvantages. Living learning community (LLC) models are one way to offer a degree of academic and social engagement that will improve academic attrition and increase retention rates. This research study was conducted at Florida Agricultural and Mechanical University (FAMU), an HBCU located in Tallahassee, Florida. A wide range of disciplines and subgroups were categorized as science, technology, engineering, and mathematics; therefore, the sample consisted of students whose fields of study were classified in the College of Science and Technology (CST).

The theoretical framework for this study includes Tinto's (1998) Model of Institutional Departure and Astin's (2012) Input-Environment-Outcome (I-E-O) College Impact Model theories. Tinto's Model of Departure theory states that an inclusive environment can effectively improve academic outcomes and reduce first-year students' departure. Astin's I-E-O theory predicts that social and academic integration, along with institutional culture, will improve student retention rates.

The study described in this article used quantitative measures to assess a science and technology LLC's impact on academic performance and retention of African American students at FAMU. A retrospective cohort analysis compared enrollment data collected between Fall 2019 and Spring 2020 of first-year science and technology students participating in the STEM LLC and those first-year science and technology students residing in on-campus residential halls. To obtain a sufficient sample for quantitative data, this study's participants were recruited as a convenience sample of first-year students enrolled in the College of Science and Technology.

A 14-question modified survey from the National Survey of Living-Learning Programs (NSLLP) (Harris, 2019) at Texas A&M University was used as the primary collection instrument for quantitative data for this study. The survey was used to measure student engagement and for students to report semester grade point averages. The data analysis consisted of computer-based, systematic statistical tests to investigate the relationship between LLC participation and student academic outcomes.

The desired outcome of this study is to contribute to the research regarding the effectiveness of LLCs on academic outcomes for minority students at HBCUs. The research study examines whether LLCs can be an effective internal retention strategy.

Methods

A causal-comparative research design is a quantitative method aimed to identify an association or connection

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between two or more groups on one or more dependent variables of interest (Umstead & Mayton, 2018). A causal-comparative design method was used to identify whether residency type acts as the reason for differences in semester grade point averages and retention rates of first-year science and technology students. This study's population was first-year science and technology students in the College of Science and Technology (CST) at FAMU. FAMU College of Science and Technology is organized into five major classifications: biology, chemistry, computer science, mathematics, and physics. To obtain a sufficient sample for quantitative data, this study's participants were recruited as a convenience sample of first-year students enrolled in the CST.

Data Collection

A 14-question modified survey from a previously validated survey by the NSLLP (Harris, 2019) at Texas A&M University was used as the primary collection instrument for this study. The survey was used to determine the relationship between residential type, student engagement, and academic success of first-year science and technology students. In addition to obtaining quantitative data, secondary archival enrollment data for first-year science and technology students were provided by the University Office of Housing as well as interactive data reporting from the Office of Institutional Research (2020).

A digital research flyer was created as a tool to recruit participants. The research flyer was posted on the College of Science and Technology (CST) social media page and emailed directly to first-year science and technology students. Emails asking for participation were sent to 61 first-year science and technology students. The actual data was collected using Jotform and transposed to an Excel spreadsheet for data analysis. The informed consent was built into the Jotform as a question. A copy of the informed consent is attached in Appendix B.

The survey consisted of 13 multiple-choice questions and one write-in response. The first five questions following the informed consent asked participants to identify their major, gender, and ethnicity. The questions that rated the participants' feelings regarding their connection to peers, staff, and campus resources were presented using Likert rating scales 1 (agree), 2 (neither agree nor disagree), and 3 (disagree). The participants were asked to report their cumulative Fall 2020 GPA (grade point average) as a write-in response. The questionnaire was administrated electronically to first-year science and technology students in the CST. The Institutional Review Board granted ethics approval for the study. Data were collected over three weeks in March 2020.

Data Analysis

The data entry program used to analyze the data was IBM SPSS Statistics (2019). Data were entered into an Excel spreadsheet and coded for analysis. Once the data was entered, a descriptive analysis of frequencies was performed to ensure no missing data inputs. Quantitative data for questions that used Likert rating scales were analyzed for differences by LLC participants and non-LLC participants and demographics such as major category, grade point average (GPA), gender, and ethnicity. Descriptive statistics are reported for the following variables: gender, ethnicity, major, grade point averages, and student engagement values for first-year CST students participating in the CST LLC and non-LLC. The first step was to determine a statistical significance between two categorical variables; gender (male or female) and residential types (CST LLC or non-LLC). A test for normality of the data was performed by examining the shape of the variable's distribution using histogram plots and examining kurtosis and skewness statistics. The null hypothesis is that the data are normally distributed. The data was analyzed using the Shapiro-Wilk test *($p > .05$)* followed by an ANCOVA used in causal-comparative studies to determine the statistical relationship between two variables and the Chi-squared test.

Descriptive Statistics

Descriptive statistics were reported for the variables: gender, ethnicity, major, grade point averages, and student engagement values for first-year CST students participating in the CST LLC and non-LLC. A test for normality of the data was performed by examining the shape of the variable's distribution using histogram plots and examining kurtosis and skewness statistics. The null hypothesis is that the data are normally distributed. A Shapiro-Wilk's test *($p > .05$)* showed the skewness of -1.923 (SE = 0.661) and kurtosis of 2.037 (SE = 1.279) for the CST LLC participants and skewness of -0.661 (SE = 0.661) and kurtosis of -1.964 (SE = 1.279) for the non-LLC participants.

Following the normality test, a chi-squared was performed to determine a significant relationship between the categorical variables. A chi-square test of independence showed that there was no significant association between residential type and gender, $X2$ (1, N = 22 = .917), p = .338. No significant association between residential type and gender may be attributed to the small sample size. A chi-square test of independence showed that there was no significant association between residential type and major, $X2$ (2, N = 22) = 1.234, p = .540.

Research Question 1: What is a living-learning community's (LLC) effect on grade point averages of first-year science and technology students?

Academic success was measured by the students' self-reported survey response to Fall 2020 semester grade point averages. Grade point averages at Florida A&M University range from 0 - 4.0. The data was analyzed using an ANCOVA that is used in causal-comparative studies to determine the statistical relationship between residential types and grade point averages of first-year science and technology students. An analysis of the covariance test measures an LLC's effects on semester grade point averages between male and female students.

Research Question 2: What are the relationships between residence type and student engagement of first-year science and technology students?

Student engagement was measured with a 14-question modified survey from the NSLLP (Harris, 2019) at Texas A&M University. Descriptive statistics such as the median and mode were used to determine the average response for each question. The responses were analyzed by residential type (LLC and non-LLC participants).

Research Question 3: How do fall-to-fall enrollment rates differ between first-year science and technology LLC participants and non-LLC participants?

Enrollment numbers reported in this study were secondary archival data provided by the University Office of Housing as well as interactive data reporting from the Office of Institutional Research (2020). Enrollment rates were measured by the proportion of CST LLC and non-LLC participants who first matriculated in the Fall of 2019 and were subsequently enrolled at FAMU during Fall 2020.

Results

The population was first-year STEM students in the College of Science and Technology (CST) at FAMU, which is organized into five major classifications: biology, chemistry, computer science, mathematics, and physics. The University Office of Institutional Research (2020) reported that 54 students enrolled in the CST LLC and 49 CST students enrolled in non -LLC campus housing in Fall 2020. Changes to the population's environment involved social distancing due to Covid-19; students were allowed to reside on campus or at home. More than half (60%) of the students elected to live at home, and as a result, the sample pool was significantly reduced.

Data for this study were collected using a 14-question modified survey from a previously validated survey by the NSLLP (Harris, 2019) at Texas A&M University. Upon completing the survey, students were asked to provide their student identification number to validate their classification, major, and self-reported grade point average with the Office of Institutional Research. A total of 22 students participated in the research study. All 22 participants identified their ethnicity as African American. There were no physics or mathematics majors among the 22 participants. Fifty percent of the sample identified as biology majors, 32% identified as chemistry majors, and 18% as computer and information science majors. Six of the 22 participants were male; 16 were female.

Effects of a Living-Learning Community (LLC) on Grade Point Averages

Academic success was measured by the students' self-reported survey response to Fall 2020 semester grade point averages. Grade point averages at Florida A&M University range from 0 - 4.0. The data was analyzed using an ANCOVA that is used in causal-comparative studies to determine the statistical relationship between residential types and grade point averages of first-year science and technology students. An analysis of the covariance test measured an LLC's effects on semester grade point averages between male and female students. There were five assumptions of the ANCOVA test.

The first assumption was the normality of the dependent variable and covariate. The first assumption looks at the skewness and kurtosis of grade point averages and residential types. A general rule of thumb is that skewness falls between +1 and -1; this indicates that the variable is normally distributed (Hair et al., 2017). Kurtosis is a measurement of the distribution's peak**.** The rule for kurtosis is that if the number is greater than +1, the distribution is peaked, and a number less than -1 indicates a flat distribution. (Hair et al., 2017). A Shapiro-Wilk's test ($p > .05$) showed the skewness of -0.137 ($SE = 0.661$) and kurtosis of -1.422 ($SE = 1.279$) for the CST LLC participants and skewness of 0.780 ($SE = 0.661$) and kurtosis of 1.769 ($SE = 1.279$) for the non-LLC participants, indicating that the grade point averages were approximately normally distributed for CST LLC and non-LLC participants.

The second assumption was that the independent variable does not have a significant effect on the covariant. For this study, we will assume that residential type does not have a significant effect on gender. To determine this assumption, a t-test and ANOVA tests were performed. Levene's test of equality of variance between gender and residential type shows a p-value of 0.565, which is significantly greater than 0.05; therefore, residential type does not significantly affect

gender. Presented in Table 1 is the summary of a one-way ANOVA. The one-way ANOVA showed a significant difference in the residence type ($F = 20.98$; $p < .0001$). It was concluded that there was a significant effect on semester grade point averages by residential type of first-year science and technology students.

Table 1. *ANOVA: Grade Point Average by Residence Type*

Source	DF	SS	MS	F Value	Pr > F
Model (Between Groups)	1	2.938	2.938	20.98	<.0001
Error (Within Groups)	20	2.800	0.140		
Corrected Total	21	5.739			

Note. F value = variance of the group means (mean square between) / mean square error (mean square within group). P-value is significant at the 0.05 level.

The third assumption stated that the dependent variable and covariates were linearly related. Grade point averages and residential type were linearly related. The Pearson Correlation between grade point averages and residential type is -0.716, in which correlation was significant at the 0.01 level (2-tailed). The results of a correlation analysis showed that grade point averages and residential types were correlated. Presented in Table 2 are the descriptive statistics of grade point averages for LLC and non-LLC participants.

Table 2. *Mean and Standard Deviation of GPA by Residential Type*

Residential Type	n	M	SD
CST LLC	11	3.62	0.25
Non-LLC	11	2.89	0.47
N = 22			

The fourth assumption was the homogeneity of regression means there were no significant interactions between the dependent variable and covariates; gender and residential type. In order to do this, we looked into the interaction effect of gender and grade point averages. Ideally, there should be a non-significant relation if the p-value is greater than 0.05. The p-value between gender and grade point average was .414, which indicated no significant interaction between gender and residential type, and homogeneity of regression holds.

The last assumption was the homogeneity of variance. A one-way ANCOVA was conducted to compare the effectiveness of residential type on grade point averages while controlling for gender. Levene's test and normality checks was carried out, and the assumptions were met. There was a significant difference in the mean of grade point averages between residential types. Table 3 presents the summary of a one-way ANCOVA. The one-way ANCOVA showed a significant difference in the residence type ($F = 18.607$; $p < .009$).

Table 3. *ANCOVA: Grade Point Average by Residence Type*

Source	DF	SS	MS	F Value	Pr > F
Model (Between Groups)	2	3.799	1.900	18.63	<.009
Error (Within Groups)	19	1.940	0.102		
Corrected Total	21	5.739			

Note. F value = variance of the group means (mean square between) / mean square error (mean square within group). P-value is significant at the 0.05 level.

The Relationships Between Residence Type and Student Engagement

Participants were asked to rate how often they were able to connect with students, faculty. and staff (professors, advisors, etc.) within their major, using Likert rating scales 1 (always), 2 (sometimes), and 3 (never). Seventy-six percent of the students felt connected with their peers. Eighty-six percent of the students stated that they were more connected to their professors while living on campus.

Participants were asked to rate how often they were able to connect to resources specific to their major on campus using Likert rating scales 1 (always), 2 (sometimes), and 3 (never). Eighty-seven percent of the students stated that they were connected to campus resources while living on campus.

Participants were asked to rate how living on campus has helped them to succeed academically, using Likert rating scales 1 (agree), 2 (neither agree or disagree), and 3 disagree). The results from the questionnaire showed that 55% of students who participated in the LLC agreed that living on campus had helped them to succeed academically, while 45% neither agreed nor disagreed. 27% of non-LLC participants agreed that living on campus has helped them succeed academically, while 73% neither agreed nor disagreed.

Participants were asked to rate how living on campus has made them feel more confident about pursuing a STEM major in the College of Science and Technology, using Likert rating scales 1 (agree), 2 (neither agree nor disagree), and 3 (disagree). Fifty-five percent of students who participated in the LLC agreed that living on campus had made them feel more confident about pursuing a career in STEM. Thirty-six percent of non-LLC participants agreed that living on campus had made them feel more confident about pursuing a career in STEM.

Participants were asked to self-report their Fall 2020 cumulative grade point averages. The average GPA of the students who participated in the CST LLC was 3.62. The average GPA of non-LLC participants was 2.89.

Fall-to-fall enrollment rates differ between LLC participants and non-LLC participants

Student retention for this study is defined in two systems: retention of first-year science and technology participants of the CST LLC and retention of first-year science and technology students at the university. Enrollment rates were used to measure retention. Enrollment rates were measured by the proportion of CST LLC and non-LLC participants who first matriculated in the Fall of 2019 and were subsequently enrolled at FAMU during Fall 2020. The overall retention rate for first-year science and technology at the university between Fall 2019 and Fall 2020 was 84%, indicating that 238 of the 282 enrolled in Fall 2019 continued their enrollment at the university in the CST for Fall 2020. The programmatic retention rate was 91%; of the 282 students of the Fall 2019 cohort, 53 students participated in the CST LLC program, and 48 remained as CST majors after their first year.

Discussion

This study examined the impact of a STEM living-learning community on academic success and programmatic retention of first-year science and technology students at a Historically Black College and University (HBCU). The three research questions analyzed centered around the living-learning community (LLC) effect on grade point averages, student engagement, and enrollment rates of first-year science and technology students. Astin's student involvement theory was used as the conceptual framework for this study to show how social and academic integration components in an LLC are fundamental to academic performance and success for first-year students. Tinto's model of student departure theory states that social and academic integration and institutional culture will improve student retention rates. The findings attest that LLCs play a significant role in student engagement, integration, academic success, and persistence of first-year college students.

Academic Success

This research project examined the impact of the LLC on the academic success of first-year science and technology students compared to non-LLC students. Stassen (2003) explored students' social and academic outcomes in three different learning community models. One of the models examined is the Talent Advancement Program. This learning community model resembles the one studied in this project one that is selective in its admissions process and is open to first-year students who share a similar course of study. Academic success for this project was measured by grade point averages of first-year science and technology students. Stassen's (2003) study found that students showed more positive academic outcomes regarding grade point averages than students not in a learning community.

A study regarding the academic performance of Black male students at an HBCU concluded that grade point averages and retention of Black male students were higher for those belonging to an LLC than those not in an LLC (Clinton et al., 2020). Similarly, the data of this study support the idea that the learning community has a positive impact on grade point averages of first-year science and technology students who participated in the LLC compared to those who resided in traditional residence halls. LLC participants' grade point averages were 26% higher than those of non-LLC participants. One of the College and Science and Technology LLC's goals was to "introduce a sturdy bond between the students' learning experiences" in hopes that it would improve academic performance (Wilkerson, 2017).

Student Engagement

This study sought to determine the relationship between residential type and student engagement of first-year science and technology students. Previous studies have shown a direct correlation between learning community participation and student engagement which is the component that had the most effect on learning outcomes, as proven by statistical and qualitative data (Pike et al., 2011; Rocconi, 2011; Szelényi

et al., 2013). Reports from first-year students at small private institutions who reside in a STEM-focused LLC state that the LLC provided a place of connection and a significant source of identity while also creating an unintentional barrier to making friends outside the community (Dean & Dailey, 2020).

Williams and Johnson (2019) conducted a quantitative analysis that supports Astin's (2012) student involvement theory to determine the effectiveness of student and faculty interactions for African American college students at a historically black university. This study compared student engagement responses of participants of the LLC to non-LLC. It concluded that campus living played a significant role in how students experienced connections to their peers and faculty. The students reported being more connected with faculty than with their peers. It is possible that due to modified campus living conditions caused by the pandemic, students to faculty engagement were more significant than student-to-peer engagement for both LLC and non-LLC students.

Enrollment Rates

LLCs have been proven to improve retention and promote student success in academic STEM fields. This study determined how fall enrollment rates differ between first-year science and technology LLC participants and non-LLC participants. Student retention for the study is defined in two systems: retention of first-year science and technology participants of the CST LLC and retention of first-year science and technology students at the university. Enrollment rates were used to measure retention. Institutional culture and academic and social integrations are substantial factors for improving retention for African American students (Demetrious & Schmitz-Sciborski, 2011).

From a programmatic standpoint, the results from the NSLLP demonstrate that LLC participation improves academic success and increases graduation and retention rates (Brower & Inkelas, 2011). This study shows that programmatic retention rates of LLC participants are slightly higher than those in non-LLC by 7%. Visher et al. (2012) examined living learning programs (LLP) and their effect on retention at six different community colleges and determined that the LLPs did not affect student persistence. Persistence was determined by socioeconomic status and financial aid; students receiving financial aid were likely to re-enroll the subsequent semester regardless of their participation in an LLP. According to Pew Research Center (Anderson, 2017), HBCUs are smaller institutions compared to most postsecondary institutions of higher learning, with more than half of these schools serving 2,500 or fewer students. Britto (2020) reports that HBCUs provide a haven for minority students by offering a diverse faculty, smaller class sizes, and a learning environment conducive to promoting and recognizing social and ethnic differences. Cultural factors and environmental influences at an HBCU play significant roles in how students of color are persistent in their studies; therefore, an LLC or LLP may not play a significant role in influencing retention.

Limitations

The first limitation of this study is the small sample size of the population. The study's data collection was limited to convenience sampling due to the Covid-19 pandemic regulations, which changed the study's population environment to include social distancing measures. These changes affected the sample size. In 2019 first-year science and technology students residing on campus were approximately 89%, while in 2020 first-year science and technology students residing on campus was reduced to 25% (Office of Institutional Research, 2020).

Another limitation is the inability to set up a true experimental design, including the potential for self-selection bias associated with students electing to participate in an LLC program. This study attempted to identify and compare the differences between populations in both living scenarios. Unmeasured qualitative variables such as student economic challenges, motivations, and family ties may impact the measures of student engagement and retention.

Finally, the study was conducted at a single institution, which serves mostly underrepresented minorities. Students may perform differently academically due to their institution's social environment and benefit from participating in an LLC in a way that is not observed at other institutions in which they are ethnically in the minority.

Recommendations

An implication for future studies regarding the effectiveness of STEM LLCs is to compare and contrast different learning community types, including online and virtual learning communities, and how they directly or indirectly affect how students socially integrate and perform academically. It is also recommended to study the impact of nontraditional and online learning communities at 4-year and community colleges on the academic success of STEM students. Future studies on the effectiveness of LLCs on student success should include other quantitative learning measures to determine students' academic success. There are limited studies regarding the influences of STEM majors at an HBCU; therefore, the last recommendation is for a qualitative study that will provide insight into first-year students' interest in STEM. Knowing why students are interested in STEM and measuring academic success in ways other than examining grade point averages can help HBCUs

foster their living-learning communities and learning environment to support and promote success in STEM.

Conclusions

This quantitative study explored the impact of a STEM LLC on first-year science and technology student's success and programmatic retention at Florida A&M University, a public HBCU. A 14-question modified survey from the National Survey of Living-Learning Programs (NSLLP) (Harris, 2019) at Texas A&M University was used to rate students' social experience with faculty, peers, campus resources, academic resources, and achievement. Students' success was measured by the cumulative Fall 2020 grade point averages of first-year science and technology students participating in the LLC and compared to students who reside in traditional residence halls. The study also compared Fall 2019 and Fall 2020 enrollment rates of first-year CST LLC participants to non-LLC participants. The study found that an LLC can be an asset and valuable contribution to students' academic success. The results of this study can be used to add depth to the programmatic and institutional approaches to increase minorities in STEM and improve retention of minority students at an HBCU. Living learning communities and the college environment are positive attributes to first-year college students and are one way to improve academics and persistence in postsecondary education.

Although a STEM LLC was the focus of this study, LLCs' ability to integrate social interactions and academic experiences is also an effective strategy that can be used across multiple disciplines to enhance learning. According to Thomas and Eason (2019), LLCs work best when program administrators and student affairs staff work collectively to "create an integrated curricular and co-curricular" agenda for LLC residents. This study showed that participants of both the LLC and non-LLC felt connected to their peers and faculty. Additional research is needed to investigate LLC curricula and their effectiveness on peer and faculty interactions and campus support. A collaborative curriculum may enhance social integration, allowing first-year college students to experience having a family away from home. and provide a learning environment that supports their academic and social life endeavors.

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Appendix

A 14-question modified survey from the National Survey of Living-Learning Programs

Eligibility for study

1. A College Freshman in the College of Science and Technology
2. A student living in any of the University housing facilities (residential halls, towers, LLC, or villages)

Survey

1. Email Address
2. Please provide your university student ID number
3. Gender
   - Male
   - Female
4. Major
   - Chemistry
   - Biology
   - Computer and Information Science
   - Mathematics
   - Physics
5. Ethnicity
   - Black or African American
   - White
   - American Indian or Alaska Native
   - Asian
   - Native Hawaiian or Pacific Islander
   - Other
6. Fall 2020 Overall Semester Grade Point Average (GPA)
   - 4.00 - 3.50
   - 3.49 - 3.00
   - 2.99 - 2.00
   - Below 1.99
7. Are you a participant of the College of Science and Technology (CST) Living Learning Community (LLC)?
   - Yes
   - No
8. Did you make friends within your residence hall freshmen year?
   - Yes
   - No
9. Do you feel living on campus has helped you to succeed academically?
   - Agree
   - Neither agree nor disagree
   - Disagree
10. Do you feel living on campus has made you feel more confident about pursuing a STEM major in College of Science and Technology?
    - Agree
    - Neither agree nor disagree
    - Disagree

11. How often do I study with people that reside within my residence hall?
    Always
    Sometimes
    Never
12. How often have I been able to connect to faculty and staff (professors, advisors, etc.) within my major?
    Always
    Sometimes
    Never
13. How often have I been connected to resources on-campus specific to my major?
    Always
    Sometimes
    Never
14. Please provide your Fall 2020 Overall Semester Grade Point Average