EXAMINATION OF THE RELATIONSHIP BETWEEN STUDENT ACADEMIC OUTCOMES AND USAGE OF THE CAMPUS RECREATIONAL FACILITY

A Thesis
Submitted to the Graduate Faculty
of the
North Dakota State University
of Agriculture and Applied Science

By

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In Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE

Major Department:
Statistics

June 2016

Fargo, North Dakota

North Dakota State University
Graduate School

Title

Examination of the Relationship Between Student Academic Outcomes and Usage of the Campus Recreational Facility

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

The purpose of this thesis is to examine the relationship between student academic outcomes, such as grade point average (GPA) and retention, and usage of the campus recreational facility. The population of interest was first-time full-time degree seeking freshmen. It was found that as the mean high school GPA of students increased, the frequency of visits to the recreational facility increased. In the analysis of first-term GPA, as the term GPA increased, so did the visit frequency. For male students, the statistical significance in the mean term GPA by visit category became less distinct as the high school GPA increased. The opposite was true for female students. The final analyses assessed first- to second-year, first- to third-year, and second- to third-year retention rates. In most analyses, statistically significant differences in retention rates were present between various visit categories; however, term GPA was the most significant predictor of retention.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to my advisor, Dr. Megan Orr, for her guidance and encouragement throughout the course of this thesis. I thank her for ever so patiently answering all of my questions, willingness to meet with me at the drop of a hat, and for the positive attitude and words of encouragement when I needed it the most.

I would also like to thank my committee members for contributing their time and energy to this thesis. Dr. Mary Larson for her enthusiasm and drive to further this research; Dr. Seung Won Hyun for his insight and perspective; and Mr. Curt Doetkott for asking tough, thought-provoking questions and for his approach to applied learning. I value the expertise of each member and am greatly appreciative of the feedback each provided.

DEDICATION

To Mom, for always believing in me and showing by example the importance of education and compassion. I would not be where I am today without your unconditional love, support, and encouragement. To my children, Ciara and Colton; thank you for sharing my time and attention, your witty humor, contagious laughter and endless encouragement. You bring joy and purpose to my life. To Chuck, my biggest cheerleader; words cannot express my gratitude. You kept me grounded when I needed it the most. Thank you for believing in me, your endless support and always encouraging me to shoot for the stars.

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INTRODUCTION

Institutions across the United States are spending millions of dollars to build, or renovate, recreational facilities on their campuses (Woodhouse, 2015). A quick internet search returns list after list of what are considered to be the most amazing, luxurious, or impressive campus recreational centers in the United States. Lindsey & Sessoms (2006) conducted a survey on campus recreational facilities and the impact of these facilities on student recruitment and retention. Thirty-one percent of the survey respondents reported a recreational facility was important/very important in determining whether or not to attend the university; and 37.3% reported recreational facilities were important/very important in their decision to remain at the institution (Lindsey & Sessoms, 2006). If campus recreational facilities play a role in a student's decision to attend a university, does this facilitate greater student academic success? The objective of this thesis is to further understand the relationship of recreational facility usage and student academic success, specifically term grade point averages and retention.

Extensive research has been done with regard to the health benefits of physical activity. The Centers for Disease Control and Prevention list weight management, reduced risk of disease (e.g. cardiovascular disease, type 2 diabetes, cancer), and improved mental health among the many benefits of exercise (Centers for Disease Control and Prevention, 2015). Exercise has also been identified as an excellent tool for stress management. The Mayo Clinic explains that exercise, regardless of activity, increases the release of endorphins and can serve as a form of meditation, thus improving mood and aiding in stress relief (Mayo Clinic, 2015). With newfound freedom and responsibilities, first-year students are experiencing a substantial transitional period which is often accompanied by great uncertainty, anxiety and stress. The

readily accessible recreational facilities on campuses can serve as a great resource and outlet for students to manage their stress through a variety of sports and activities.

In addition to the health benefits of physical activity, one must consider student involvement and engagement within the university. Astin (1984) suggests the more involved the student, including both academic (e.g. studying) and non-academic (e.g. co-curricular activities, interaction with students and faculty, time spent on campus) activities, the more successful the student. A natural result of recreational facility usage is interaction with fellow students, and thus more involvement in campus life.

In this thesis, academic preparedness of incoming students will first be assessed. Statistical tests will be conducted to formally assess differences among various recreational facility usage frequency categories. If statistically significant differences are identified, post-hoc tests will be conducted to identify where these differences lie. Next, using the student preparedness analysis results to assist in model development, first-term grade point average will be assessed; again, comparing academic performance among various recreational facility usage frequency categories. Post-hoc tests will be conducted as appropriate. Lastly, the relationship between recreational facility usage and student retention will be assessed.

LITERATURE REVIEW

Current research specifically related to institutional recreational facility usage and student academic outcomes is somewhat limited. Those that have pursued this area of research, however, draw upon two well-founded theories in higher education; Alexander Astin's Theory of Involvement (1984) and Vincent Tinto's Theory of Departure (1975; 1988). Astin (1984) defines involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" and suggests this is directly related to a student's success. Defining 'academic experience' goes well beyond the amount of time and effort a student spends on studying and coursework. It is intended to encompass active participation in extracurricular activities, interactions with fellow students as well as faculty, and how much time a student spends on campus (Astin, 1984). Tinto (1975) suggests that while the various attributes and experiences (e.g. sex, race, high school GPA, family background) that follow a student to the institution play a role in their decision to persist, the largest influence comes from the student's ability to effectively integrate into the university's academic and social systems. Both of these theories revolve around the ability of a student to successfully transition and integrate themselves into the college experience. Campus recreational facilities can serve as the medium for these interactions, both with fellow students and faculty, setting the groundwork for success and persistence. A student survey conducted by Miller (2011) at Troy University found that students felt the campus recreational facility "provided strong emotional ties for them at the university" and that it was "essential in creating a social bonding experience." Henchy (2011) reports similar findings with 81% of survey respondents agreeing involvement in the programs at the recreational facility helped them feel more at home, and 34 % felt their sense of belonging increased through these interactions.

If recreational facilities are aiding in the facilitation of a student's sense of belonging and integration within the university, analyzing the relationship between student academic outcomes (e.g. institutional grade point averages, retention) and usage data are a natural progression. Belch, Gebel and Maas (2001) are among the first researchers to analyze this relationship using institutional data, specifically targeting first-time full-time students. Recreational facility users were found to have earned higher GPAs at the end of the first year, and also had higher second-term and first-year retention rates (Belch, et al., 2001). Interestingly, non-users in this study were found to have higher test scores (i.e. ACT, SAT) and higher high school GPAs than students who visited the recreational facility (Belch, et al., 2001). The research of Belch, et al., (2001) offers great insight into the relationship between recreational facility usage and student academic outcomes, however, it is not without its limitations. The use of two-sample t-tests to compare users and non-users does not allow for the inclusion of factors that may explain differences between the two groups, such as high school GPA and ACT scores. Students that enter the institution more academically prepared may be inclined to naturally have higher college GPAs, and thus, this should be taken into consideration when comparing groups. In addition, using the recreational facility visit data as a binary variable does not allow for more in depth analyses.

Through the use of a logistic regression model, Huesman, Brown, Lee, Kellog & Radcliffe (2009) were able to control for additional factors in the analysis of retention and graduation rates. Using the count of visits to the recreational facility in a logistic regression model, while controlling for other factors (e.g. test scores, high school GPA, race, residency, Pell grant status), Huesman et al. (2009) concluded recreational facility visits significantly influenced the predicted probability of both first-year retention and 5-year graduation and that there was a

positive association between the number of visits and student success. Kampf & Teske (2013) also found recreational facility usage was significant as a predictor of retention. After controlling for academic and demographic variables, Kampf & Teske (2013) concluded students who utilized the recreational facility had a higher likelihood of enrolling the following fall semester. Specifically, every "one-unit increase in student recreation center entry counts increased the odds of enrolling the following year by 1.44 times."

Most of the research on recreational facility usage appears to be focused on first-year retention and there is a lack of research comparing college GPAs between users and non-users. Zizzi, Ayers, Watson II & Keeler (2004) tried to assess the role of the recreational facility on student GPA through a student survey; users were surveyed at various times upon entrance of the recreational facility and attempts were made to survey non-users through selected courses. Their results did not find a significant difference in self-reported GPAs, however, there are admittedly limitations with the survey. Zizzi et al. (2004) further explained the student-reported GPAs of both users and non-users were higher than the institutional average and may be a result of the methods used to distribute the survey. Students visiting the recreational facility, as well as students attending class, may inherently be more active in campus life and show greater academic concern resulting in higher GPAs (Zizzi, et al., 2004).

A major goal of this thesis is to provide useful information with regard to academic success and recreational facility usage, as well as to expand the research beyond first-year retention.

DATA DESCRIPTION

The data used in this study were provided by a four-year, large, primarily residential Midwestern University (The Carnegie Classification of Institutions of Higher Education, 2015). The data set contains academic and campus recreational facility usage data for more than 16,000 first-time full-time undergraduate degree seeking students from Fall 2008 through Fall 2014. For the purposes of this study, a first-time student is defined as an undergraduate degree-seeking student who has no previous postsecondary experience, with the exception of students who attended college for the first time in the prior summer term, or students who enter with advanced standing, i.e. earn college credits prior to high school graduation (National Center for Education Statistics, 2015). Students who were identified as an NCAA Intercollegiate athlete were excluded from the analyses as this small subset of students have underlying differences from the rest of the first-year population. For example, student athletes must adhere to NCAA eligibility requirements, which include but are not limited to, minimum term GPA requirements and satisfactory progress towards degree completion (NCAA, 2015). In addition, student athletes often have additional academic resources, e.g. tutoring, as well as specialized fitness facilities which make it difficult to accurately track recreational facility usage.

Academic Variables

The variables obtained from the student database system, and used in this study, include "Gender," "Cohort," "HS_GPA," "ACT_COMP," and "TERM_GPA." The variable "Cohort" represents the fall cohort in which a student belongs. For example, a student in the FALL2008 cohort entered the institution for the first time as a full-time student during the Fall 2008 term. Incoming first-year students are placed in cohorts every fall term, and can only be represented in one cohort. The variable "HS_GPA" is the student's final high school grade point average

(GPA) as provided on the high school transcript. The high school GPA is on a 4-point scale, with possible values ranging from 0.00 to 4.00. The variable "ACT_COMP" is the student's overall ACT test score, formally referred to as the "Composite Score." The ACT Composite score is an average of the scores in the four subject tests, English, Mathematics, Reading, and Science, with a score range of 1 to 36 (ACT, 2015). Students are allowed to take the ACT test multiple times, and thus may have multiple scores on file. In these instances, the largest ACT composite score was used. The variable "TERM_GPA" is the student's end-of-term GPA for the respective fall term. Similar to high school GPA, term GPA is on a 4-point scale, with possible values ranging from 0.00 to 4.00.

Recreational Facility Usage

The University's recreational (REC) facility requires all students to swipe their student ID card for admittance into the facility. Each time a student swipes their card, it registers as one visit at the recreational facility. The REC visit data provided for this study is a count of the number of times a student swipes their student ID card at the facility for the specified semester. The variable "VCAT" was created by grouping the visit counts into five categories: 1-8, 9-16, 17-24, 25-32 and 33+. The visit category ranges were selected based on input from the recreational facility administration. Students who did not have a single swipe at the REC facility were placed in a sixth category, 0, for non-REC users. A categorical approach to REC usage was used in the analyses for comparison purposes, as well as to control for potential outliers.

METHODS

Student Preparedness

The first question addressed in this study pertains to the preparedness of incoming first-year freshmen students. More specifically, do students who utilize the REC facility their first semester entering the university have higher high school GPAs and ACT scores? If so, what is the relationship between high school GPA and ACT score and student visits to the REC facility in a semester? First, descriptive methods will be used to summarize and visualize the data. Boxplots and mosaic plots will be used to assess the distribution of visit category by gender and cohort year. Histograms will be used to assess the distribution of the academic variables high school GPA, ACT score, and term GPA; and bar charts will be used to summarize the mean values by visit category. Since the data analyzed is comprised of seven fall cohorts, this additional source of variation needs to be addressed in the model. To control for this additional variation, a generalized linear mixed model with a Gaussian distribution and identity link function will be used to analyze high school GPA and ACT scores, treating the cohort year as a random effect. If significant differences between mean high school GPA or ACT scores are detected, least squares means (LS-means) will be used to conduct pairwise comparisons for the six REC facility visit groups. Kramer's extension of Tukey's Multiple Range Test, which allows for unequal sample sizes in the p-value adjustments, will be used to control the familywise error rate (Kramer, 1956; Tukey, 1952) . Historically, female students at this institution have higher grade point averages than their male counterparts. While we need to control for gender differences in the analyses, the main focus of this study is not to formally analyze gender differences, therefore, separate models will be used for male and female students.

First-term GPA Outcomes

Following the analysis of student preparedness, the mean term GPA of the six REC facility visit categories will be compared. A generalized linear mixed model with a Gaussian distribution and identity link function will be used to make these comparisons. Predictor variables of interest for the model include HS_GPA, ACT_COMP, and VCAT. The variables chosen for this analysis will depend upon the results of student preparedness analyses. Cohort year will again be included in the model as a random effect. The Tukey-Kramer Multiple Range Test will be used to conduct pairwise comparison as appropriate. As with previous analyses, separate models will be used for male and female students.

Retention

Next the retention rates among the six visit category groups will be compared. Three approaches will be taken in the retention analyses. The first and second approaches will compare first- to second-year and first- to third-year retention rates, respectively. The third approach in the retention rate analyses will analyze students who were retained to the second-year, and compare the second- to third-year retention rates based upon the number of visits to the REC facility during the students' second fall semester of enrollment. As with all previous analyses, the REC facility visits in the second fall term will be grouped into six categories.

The predictor variables of interest in the retention analyses are TERM_GPA, HS_GPA, ACT_COMP, and VCAT. The variables used in the final model will depend upon the results of the student preparedness and term GPA analyses. The retention rates will be compared using a generalized linear mixed model with a Binary distribution and Logit link function. As in previous analyses, cohort year will be included in the model as a random effect. The Tukey-Kramer Multiple Range Test will be used to conduct pairwise comparisons as appropriate.

RESULTS

Student Preparedness

Visit Category

Figure 1 shows the distribution of visits within the visit category of '33+'. In the male population, it is clear there are four extreme outliers, ranging from 198 to 298 visits in a fall term. The standard length of a fall term is 16 weeks, therefore, 198 visits averages out to more than 12 visits per week. Due to the extreme values, these four observations were removed from all analyses. No observation in the female student population were extreme enough to justify removal.

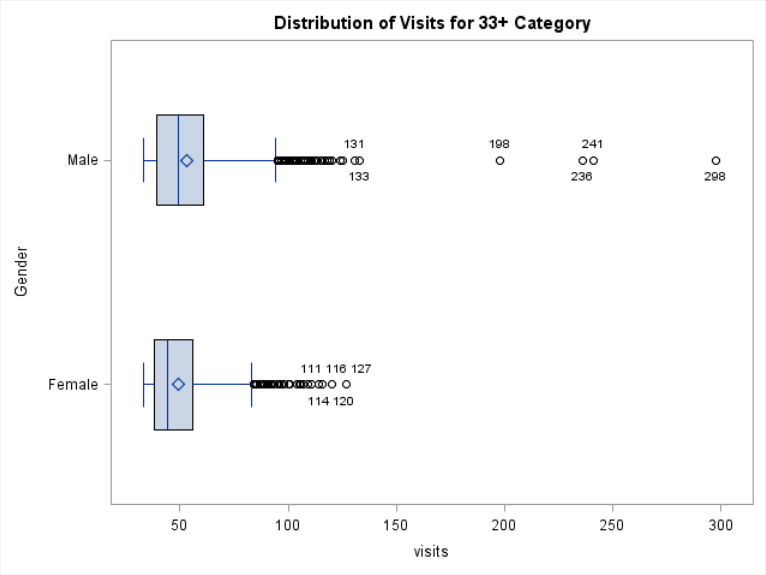

Figure 1. Distribution of Visits for 33+ Category

The distribution of visits in each cohort year are shown in Figure 2. There are mild fluctuations from year to year, however, no obvious increasing or decreasing trends are present. The percent of students within each cohort that do not visit the REC facility their first fall semester is held fairly constant at approximately 12-15%. The largest proportion of visits, both in male and female students, fall within the '1-8' visit category. The second largest visit

category for male students is ‘33+’, and for female students is ‘9-16’. In general, male students visit the REC facility more frequently than female students.

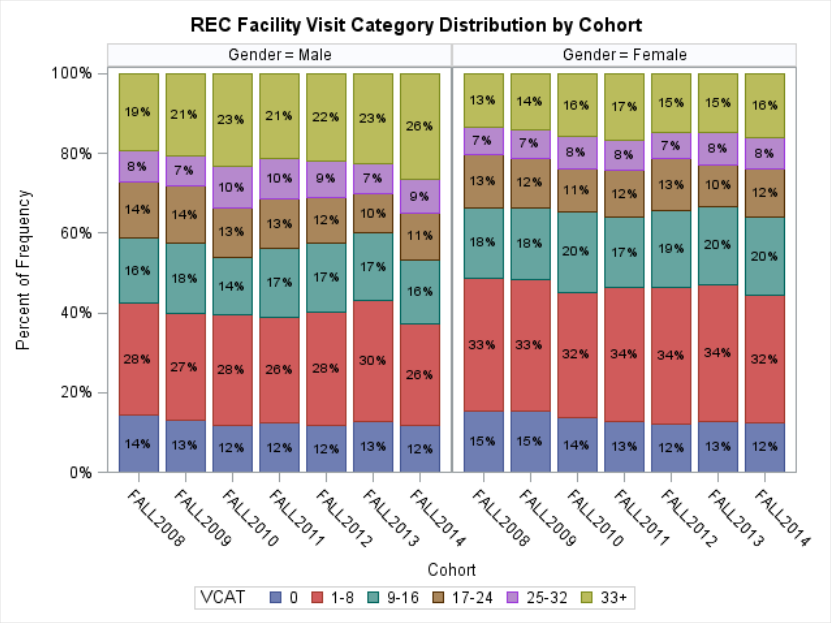

Figure 2. Visit Category Distribution by Cohort

High School GPA

Students who had a high school GPA of zero (n=6) were excluded from summarizations and analyses as these values can most likely be attributed to data entry error. The institution’s current admission requirements recommend a high school GPA of at least 2.75 on a 4.0 scale, however, consideration is given to students who have lower high school GPAs and higher test scores, such as ACT. As seen in Figure 3, both male and female mean high school GPAs are notably higher than the recommended GPA for admission at 3.33 and 3.47, respectively. The distributions are left skewed with some outliers.

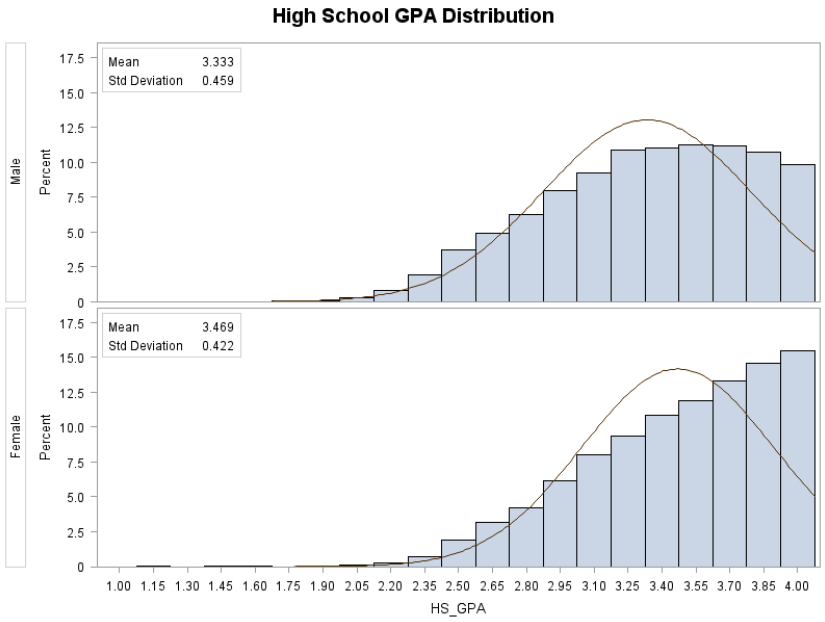

Figure 3. High School GPA Distribution

Figure 4 shows an overall increasing trend in high school GPA as number of visits to REC facility increases. In both male and female populations, the largest difference is between students who do not visit the REC facility in their first semester and those who had 33 or more visits; a difference of 0.143 for male students, and 0.254 for female students.

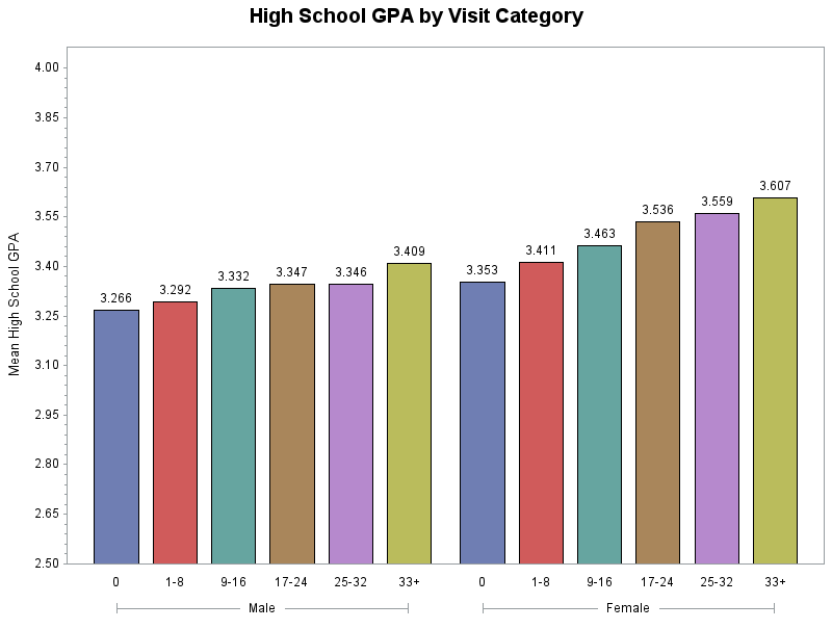

Figure 4. High School GPA by Visit Category

A generalized linear mixed model with a Gaussian distribution, identity link function and random cohort effect was run for male and female students separately. The results for male students will be discussed first.

For male students, the type III test of fixed effects suggests there are statistically significant differences ($p<.0001$) in mean high school GPA among the six different visit categories. In general, the residual plots in Figure 5 show a random scatter with a slightly left-skewed distribution. Due to the bounded values of high school GPA, more so at the higher end of the scale, a distinct upper-bound is present in the scatterplot. Given the large sample size and the robustness of the model, the assumptions were considered sufficiently met and the analysis continued with the specified Gaussian distribution and identity link function. Further research may be worthwhile to identify a link function that can account for the skewness in the data and provide a better model fit. Pairwise comparisons were conducted using the Tukey-Kramer adjustment to control the familywise error rate. The Tukey-Kramer groupings are provided in Table 1 and are consistent with the initial analysis of the high school GPA summary statistics.

Male students who visit the REC facility at least 33 times in their first semester have a statistically significantly higher high school GPA than all other visit categories. In addition, male students who visit the REC facility between 9 and 32 times in the fall term have a statistically significantly higher high school GPA than those who do not visit the REC facility.

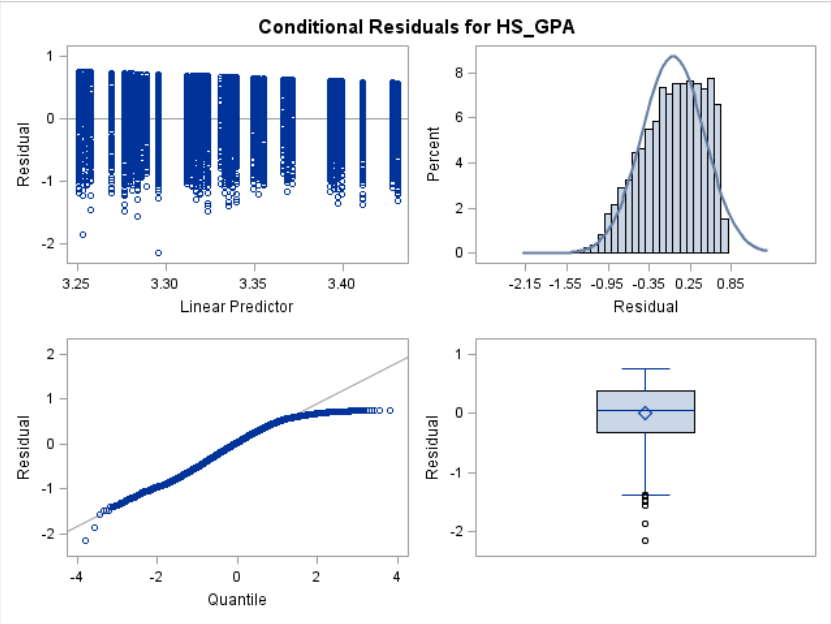

Figure 5. Diagnostic Residual Plots for High School GPA Model (Male Students)

Table 1. Tukey-Kramer Visit Category Groupings for High School GPA (Male Students)

Tukey-Kramer Grouping for VCAT Least Squares Means (Alpha=0.05)			
VCAT	Estimate		
33+	3.4079		A
17-24	3.3483		B
			B
25-32	3.3462	C	B
		C	B
9-16	3.3321	C	B
		C	
1-8	3.2919	C	D
			D
0	3.266		D

The model for the female students suggests statistically significant differences ($p<.0001$) in mean high school GPA among the six visit categories. Similar to male students, the residual plots in Figure 6 show an overall random scatter with a slight left-skewed distribution, however, the violations to not appear significant enough to cause concern. The Tukey-Kramer pairwise comparisons provided in Table 2 indicate female students who do not visit the REC facility in their first term have a statistically significantly lower high school GPA than those who do visit, regardless of the number of visits in the term. Additionally, female students who visit the REC facility 17 or more times in the fall term have a statistically significantly higher high school GPA than those who visit 16 or fewer times. As noted in the summary statistics, the largest difference in high school GPA is between students who do not visit the REC facility and those in the '33+' visit category.

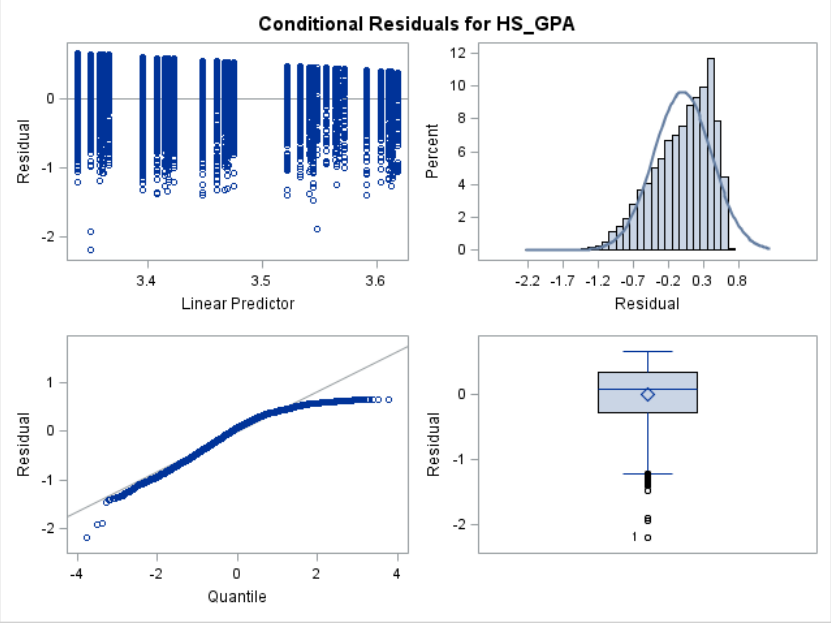

Figure 6. Diagnostic Residual Plots for High School GPA Model (Female Students)

Table 2. Tukey-Kramer Visit Category Groupings for High School GPA (Female Students)

Tukey-Kramer Grouping for VCAT Least Squares Means (Alpha=0.05)			
VCAT	Estimate		
33+	3.6062		A
			A
25-32	3.5591	B	A
		B	
17-24	3.5363	B	
9-16	3.4631		C
1-8	3.4107		D
0	3.3536		E

Even though the Tukey-Kramer groupings suggest statistically significant differences, one must also consider practical significance. The difference between visit categories '0' and '1-8' was statistically significant with a difference in GPA of 0.0571. Due to the large number of observations in the data set, the statistical tests have high power and thus can detect differences that, in a practical sense, may be considered quite small. Practical significance in GPA is not discussed in other research and, therefore, is not clearly defined.

ACT Composite Score

As previously stated in the data descriptions, the ACT composite score ranges from 0 to 36. The institution's current admission requirements recommend a score of at least 22, however, as with high school GPA, consideration is given to students who have lower ACT test scores and higher high school GPAs. The distribution of ACT score is provided in Figure 7. The distributions appear to be approximately normal with the mean scores slightly higher than the recommended admission guidelines, for both male and female students.

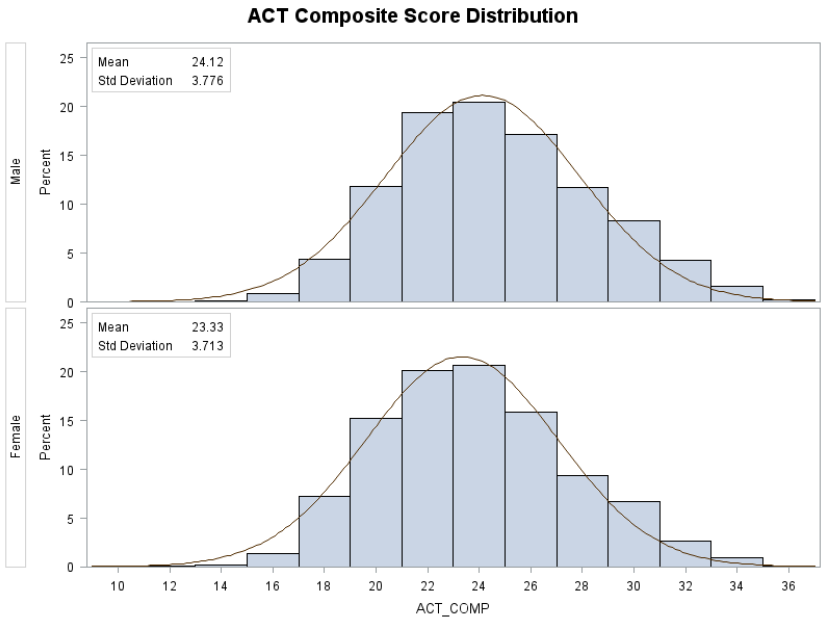

Figure 7. ACT Composite Score Distribution

As seen in Figure 8, the ACT composite score remains fairly constant regardless of the number of visits to the REC facility.

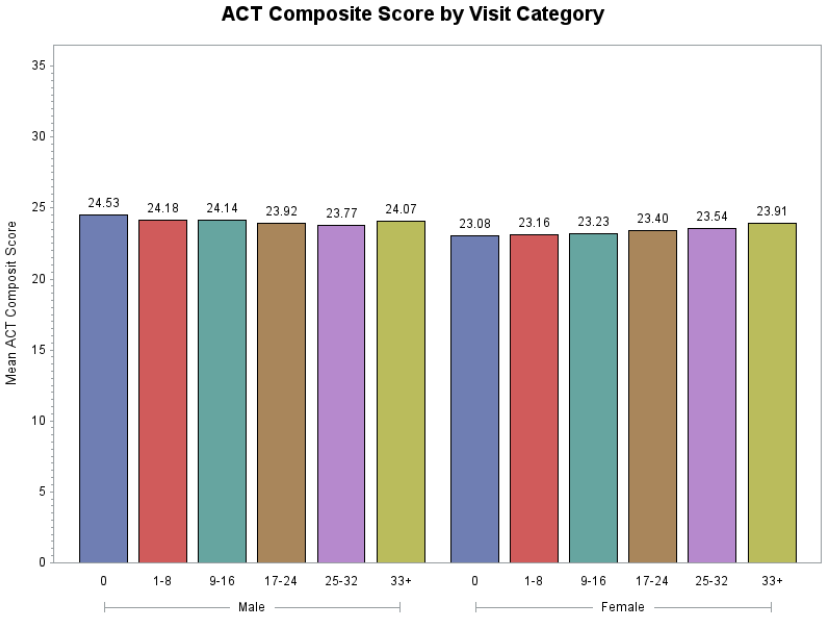

Figure 8. ACT Composite Score by Visit Category

A generalized linear mixed model with a Gaussian distribution, identity link function and random cohort effect was run to test for significant differences among the visit categories; again models were run separately for male and female students.

The model for male students had a p-value of 0.0002, suggesting statistically significant differences in the mean ACT composite score among the visit categories. The residual plots in Figure 9 verify the model assumptions have been reasonably met. Pairwise comparisons were run and the results of the Tukey-Kramer groupings can be found in Table 3. Interestingly, male students who did not visit the REC facility had a statistically significantly higher ACT score than those who visited the facility 17 or more times in the fall term, with the largest difference of 0.7775 between visit categories '0' and '25-32'. Analyzing these differences from a practical sense, the mean ACT scores for all of the six visit categories appear to be fairly close, given the maximum difference of 0.7775 on a 36-point scale. Statistically significant differences were detected among the six groups; however, practically, these differences appear to be insignificant.

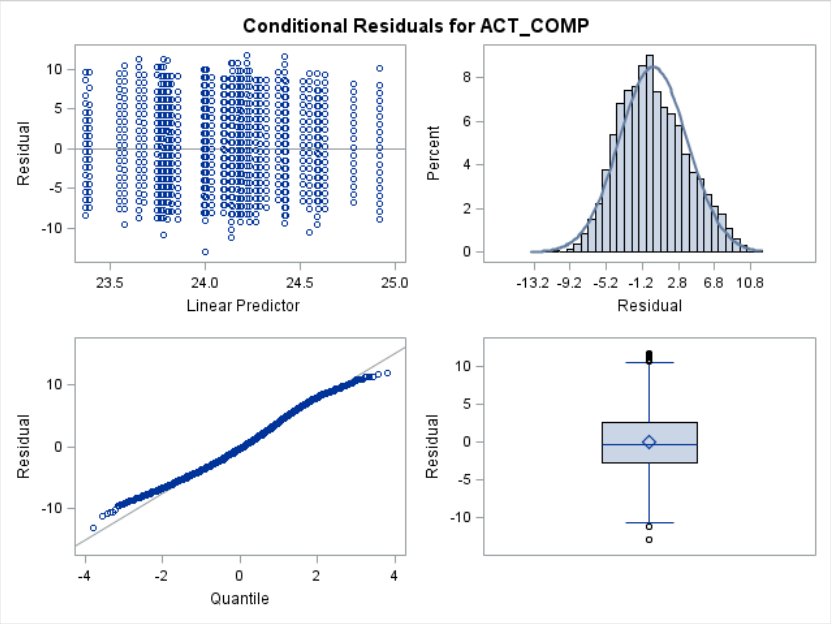

Figure 9. Diagnostic Residual Plots for ACT Model (Male Students)

Table 3. Tukey-Kramer Visit Category Groupings for ACT Score (Male Students)

Tukey-Kramer Grouping for VCAT Least Squares Means (Alpha=0.05)			
VCAT	Estimate		
0	24.5466		A
			A
1-8	24.18	B	A
		B	A
9-16	24.1443	B	A
		B	
33+	24.0534	B	
		B	
17-24	23.9493	B	
		B	
25-32	23.7691	B	

Similar to the male student population, the visit categories were found to be statistically significantly different ($p<.0001$) in the ACT scores model for female students. The residual plots in Figure 10 do not show severe model violations that may be of concern. As seen in Table 4, the largest difference of 0.8268 in ACT scores is between students who do not visit the REC facility, and those in the '33+' category. Given the largest difference among the visit categories is 0.8268, the differences among the visit categories are practically insignificant.

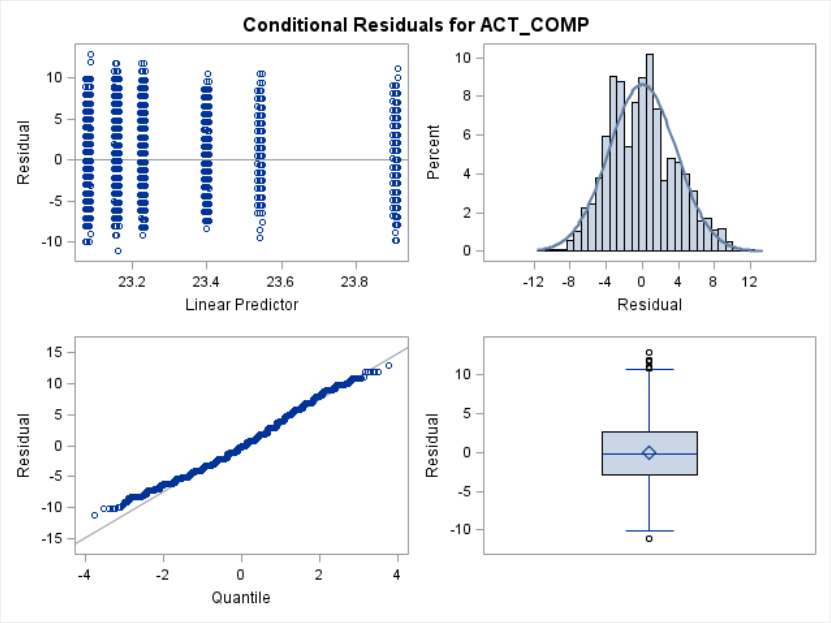

Figure 10. Diagnostic Residual Plots for ACT Model (Female Students)

Table 4. Tukey-Kramer Visit Category Groupings for ACT Score (Female Students)

Tukey-Kramer Grouping for VCAT Least Squares Means (Alpha=0.05)			
VCAT	Estimate		
33+	23.906		A
			A
25-32	23.5421	B	A
		B	
17-24	23.3991	B	
		B	
9-16	23.2278	B	
		B	
1-8	23.1565	B	
		B	
0	23.0792	B	

First-term GPA Outcomes

Next, the term GPA of the full-time first-year student population was analyzed. The distributions of term GPA, as seen in Figure 11, appear to be left skewed with no notable extreme outliers.

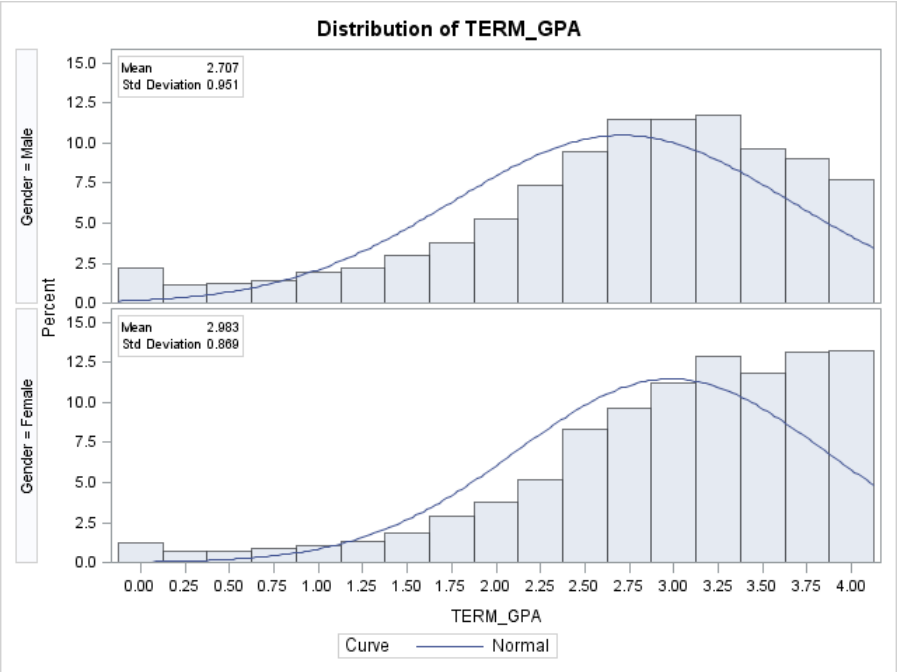

Figure 11. Distribution of Term GPA

Figure 12 shows an overall increasing trend in term GPA as the number of visits to the REC facility increases. As with high school GPA, the largest difference in term GPA for both male and female students is between those who do not visit the REC facility in their first semester and those who had 33 or more visits; a difference of 0.49 for male students, and 0.613 for female students.

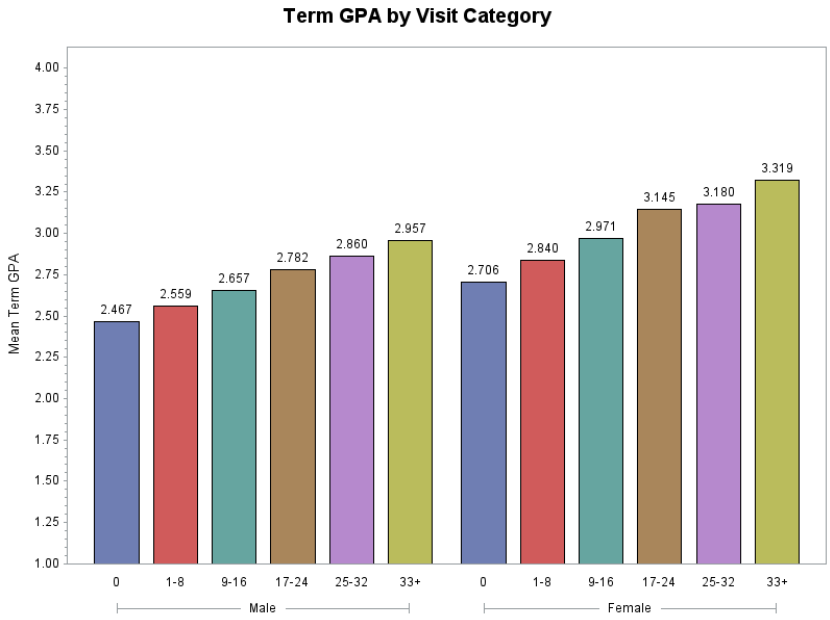

Figure 12. Term GPA by Visit Category

Thus far, the results suggest there are significant differences in the mean high school GPA and ACT scores among the six visit categories, and should be considered for inclusion in the model to assess differences in term GPAs. Pearson correlation coefficients, which are shown in Table 5, were calculated to assess the relationship between term GPA, high school GPA, and ACT score. The results are similar for both male and female students with moderately positive correlation between term and high school GPA, low positive correlation between term GPA and ACT score, and low to moderately positive correlation between high school GPA and ACT score. The scatterplots of these relationships are shown in Figure 13 to visually aid in the assessment of these relationships.

Table 5. Pearson Correlation Coefficients

Pearson Correlation Coefficients				
	GENDER	TERM_GPA	HS_GPA	ACT_COMP
TERM_GPA	Male	1.0000	0.59025	0.34036
	Female	1.0000	0.60763	0.41307
HS_GPA	Male	0.59025	1.0000	0.48568
	Female	0.60763	1.0000	0.56027
ACT_COMP	Male	0.34036	0.48568	1.0000
	Female	0.41307	0.56027	1.0000

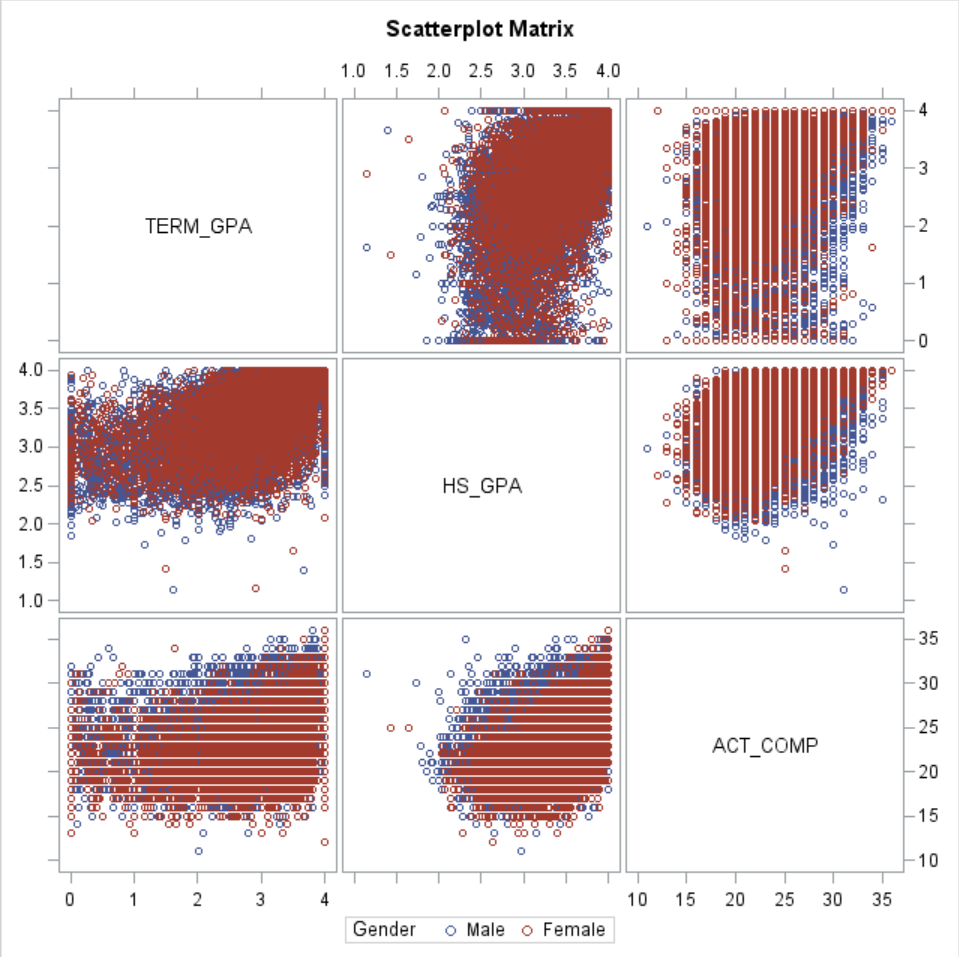

Figure 13. Correlation Matrix for Variables TERM_GPA, HS_GPA and ACT_COMP

The moderately positive correlation between high school GPA and term GPA suggests high school GPA should be added to the model as a covariate. ACT score was left out of the model as there appears to be very low correlation with term GPA. This is consistent with the analyses of ACT scores in chapter 4 in which the differences in ACT scores were found to be of little practical significance. The final model to assess the difference in term GPA for the six visit categories included high school GPA and visit category as covariates and cohort year as a random effect. Separate models were run for male and female students.

To begin the analysis of term GPA, an analysis of covariance was conducted using a generalized linear mixed model with a Gaussian distribution, identity link function and random cohort effect. The assumption of homogeneity of slopes was assessed first with the inclusion of the interaction term HS_GPA*VCAT in the model. The interaction term HS_GPA*VCAT was significant in both the male and female models, with p-values 0.0008 and 0.0010, respectively. This signficance indicates the slopes of the six visit categories are not parallel, and therefore the analysis must be performed at various levels of high school GPA. The residuals in Figure 14 do not appear to have a random scatter and is the result of the heavily bounded values of term GPA. The bulk of the residuals, however, are centered around zero and do not have a clear pattern. Given the large sample size and the robustness of the model, the assumptions were considered sufficiently met, however, further research may be worthwhile to identify a link function that can account for the skewness in the data and provide a better model fit.

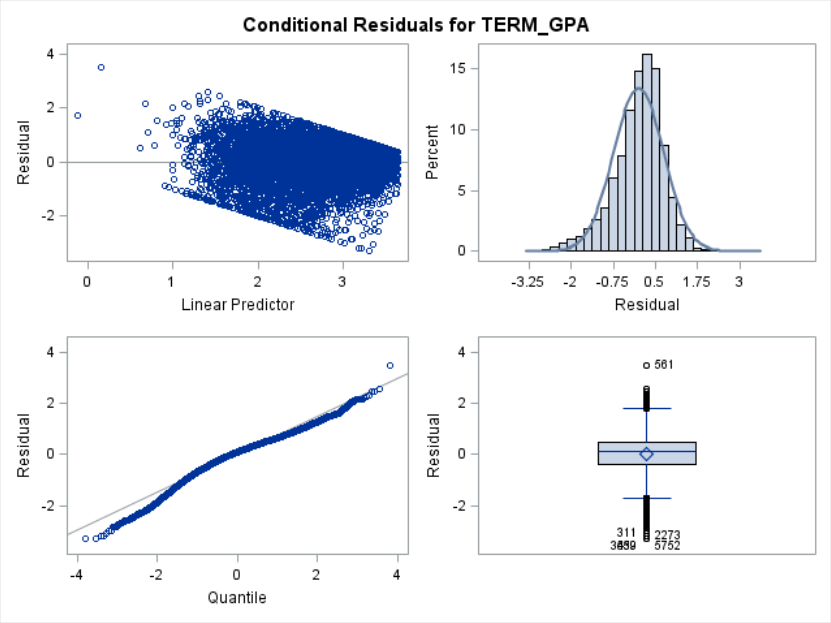

Figure 14. Diagnostic Residual Plots for Term GPA Model (Male Students)

Least squares means were calculated using the Tukey-Kramer adjustment at three values of high school GPA; 2.75, 3.25, 3.75. These three values were chosen for the analysis based on the distribution of high school GPAs. Looking at the Tukey-Kramer groupings for male students in Table 6, it can be noted that across all three high school GPA values, the term GPA for male students increases as the visit category increases. Most noticeably, as the high school GPA increases the number of Tukey-Kramer groupings increase and become less distinctive. Students who visited the REC facility 25 or more times, or an average of 1.5 times per week, during the fall term had statistically significantly higher term GPAs than students who had 16 or fewer visits.

Table 6. Tukey-Kramer Visit Category Groupings for Term GPA (Male Students)

Tukey-Kramer Groupings for VCAT Least Squares Means (Alpha=0.05)											
Gender=Male HS_GPA=2.75				Gender=Male HS_GPA=3.25				Gender=Male HS_GPA=3.75			
VCAT	Estimate	Grouping		VCAT	Estimate	Grouping		VCAT	Estimate	Grouping	
33+	2.2792		A	33+	2.8051		A	33+	3.3309		A
25-32	2.1864	B	A	25-32	2.7556	B	A	25-32	3.3247	B	A
17-24	2.1310	B		17-24	2.6707	B		17-24	3.2104	B	C
9-16	1.9568		C	9-16	2.5584		C	9-16	3.1600	D	C
1-8	1.8780		C	1-8	2.5060	D	C	1-8	3.1341	D	C
0	1.8435		C	0	2.4504	D		0	3.0572	D	

The residual plots and Tukey-Kramer groupings for female students are provided in Figure 15 and Table 7, respectively The residual plots are very similar to those seen for male students. The bulk of the residuals are centered around zero and appear to have a random scatter. As with male students, term GPA increases as the visit category increases for female students across the three high school GPAs observed. Contrary to male students, the Tukey-Kramer groupings become more distinctive as the high school GPA increases. At a high school GPA of 2.75, female students who visited the REC facility eight or fewer times during the fall term had a statistically significantly lower term GPA than students with 17 or more visits. At a high school GPA of 3.25, students who visited the REC facility nine or more times during the fall term had a statistically signficiantly higher term GPA than those who had eight or fewer visits. Female students with a high school GPA of 3.75 and did not visist the REC facility their first fall term had a statistically signficantly lower term GPA that students who had at least one visit during the semester.

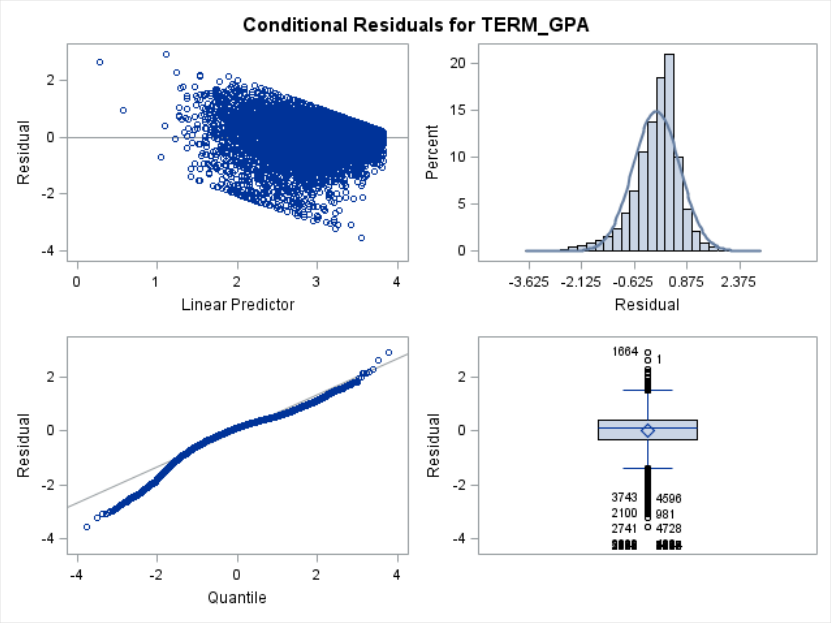

Figure 15. Diagnostic Residual Plots for Term GPA Model (Female Students)

Table 7. Tukey-Kramer Visit Category Groupings for Term GPA (Female Students)

Tukey-Kramer Groupings for VCAT Least Squares Means (Alpha=0.05)											
Gender=Female HS_GPA=2.75				Gender=Female HS_GPA=3.25				Gender=Female HS_GPA=3.75			
VCAT	Estimate	Grouping		VCAT	Estimate	Grouping		VCAT	Estimate	Grouping	
33+	2.3692		A	33+	2.9276		A	33+	3.4859		A
17-24	2.3313		A	17-24	2.8528		A	25-32	3.4070	B	A
25-32	2.2933	B	A	25-32	2.8502		A	17-24	3.3743	B	
9-16	2.1356	B	C	9-16	2.7261	B		9-16	3.3166	B	C
0	2.0559	D	C	1-8	2.6301		C	1-8	3.2694		C
1-8	1.9908	D		0	2.6029		C	0	3.1498	D	

Retention

First- to Second-Year Retention

A student was considered retained from the first- to second-year if they were enrolled for credit as of the institution's census enrollment date in the fall semester immediately following their first fall term of enrollment. For example, a student in the Fall 2008 first-year cohort was

considered retained if they were enrolled as of the census date in the Fall 2009 term. Retention rates by visit category for male and female students are provided in Tables 8 and 9, respectively. An increasing trend in retention rates as REC visit category increases is evident. Male students who had at least 33 visits to the REC facility their first fall term had a retention rate of 85.04%, compared to 67.83% for those who did not visit the REC facility. Female students had similar outcomes with 83.19% of students in the '33+' visit category retained, compared to 68.24% of those who did not visit the REC facility.

Table 8. First- to Second-Year Retention Rates by Visit Category (Male Students)

VCAT	Retained		
	No	Yes	Total Headcount
0	32.17 %	67.83 %	1,122
1-8	25.83 %	74.17 %	2,462
9-16	21.71 %	78.29 %	1,483
17-24	18.17 %	81.83 %	1,106
25-32	17.40 %	82.60 %	776
33+	14.96 %	85.04 %	1,979
Overall	*21.85 %*	*78.15 %*	*8,928*

Table 9. First- to Second-Year Retention Rates by Visit Category (Female Students)

VCAT	Retained		
	No	Yes	Total Headcount
0	31.76 %	68.24 %	1,020
1-8	25.83 %	74.17 %	2,513
9-16	20.91 %	79.09 %	1,435
17-24	16.54 %	83.46 %	901
25-32	16.17 %	83.83 %	569
33+	16.81 %	83.19 %	1,136
Overall	*22.51 %*	*77.49 %*	*7,574*

To formally assess the differences in first- to second-year retention rates among the six visit categories, a generalized linear mixed model with a Binary distribution and Logit link function with a random cohort effect was conducted. In addition to visit category, term GPA and high school GPA were also included as covariates in the model. ACT scores were not included in the model as prior analyses suggested little to no practical significance.

Two models were compared for male students. The first model consists of all variables that were found be significant at the 0.05 alpha level, which includes TERM_GPA, HS_GPA, VCAT and TERM_GPA*VCAT. The interaction between visit category and term GPA has a p-value of 0.0482, which is very close to the alpha level of 0.05. A second model removing this interaction term was run to assess the contribution of this variable to the model. The test of fixed effects for these models are provided in Table 10, and fixed effect estimates and model comparisons are in Table 11. Students were predicted to be retained if their estimated probability was greater than or equal to 0.5. Using this criteria, both models' retention predictions were 84% accurate.

Table 10. First- to Second-Year Retention Model Test of Fixed Effects (Male Students)

	Type III Tests of Fixed Effects			
	Model 1		Model 2	
Effect	F Value	p-value	F Value	p-value
TERM_GPA	702.6	<.0001	851.3	<.0001
HS_GPA	15.43	<.0001	14.57	0.0001
VCAT	2.9	0.0128	3.17	0.0074
TERM_GPA*VCAT	2.23	0.0482		

Table 11. First- to Second-Year Retention Model Estimates and Comparisons (Male Students)

Solutions for Fixed Effects and Model Comparisons			
Effect	VCAT	Model 1 Estimate	Model 2 Estimate
Intercept		-2.7365	-2.7463
TERM_GPA		1.1434	1.1625
HS_GPA		0.3072	0.2971
VCAT	1-8	-0.1102	0.1874
VCAT	9-16	0.4268	0.2831
VCAT	17-24	0.2456	0.3961
VCAT	25-32	0.0111	0.3174
VCAT	33+	0.8298	0.3459
VCAT	0	0	
TERM_GPA* VCAT	1-8	0.1363	
TERM_GPA* VCAT	9-16	-0.0626	
TERM_GPA* VCAT	17-24	0.0657	
TERM_GPA* VCAT	25-32	0.1275	
TERM_GPA* VCAT	33+	-0.1852	
TERM_GPA* VCAT	0	0	
Correct		83.60%	83.59%
False Positive		13.57%	13.58%
False Negative		2.83%	2.83%

In order to more clearly understand the relationship between retention and visit categories, the log odds as a function of term GPA from model 1 was plotted at three levels of high school GPA: 2.75, 3.25 and 3.75. These plots are provided in Figure 16. In general, the slopes of the visit categories appear to be parallel, with the exception of the '33+' group. The retention rate for male students who had at least 33 visits appears to increase more slowly as term GPA increases compared to students with fewer visits. Students who do not visit the REC facility have a clear separation from the other visit categories.

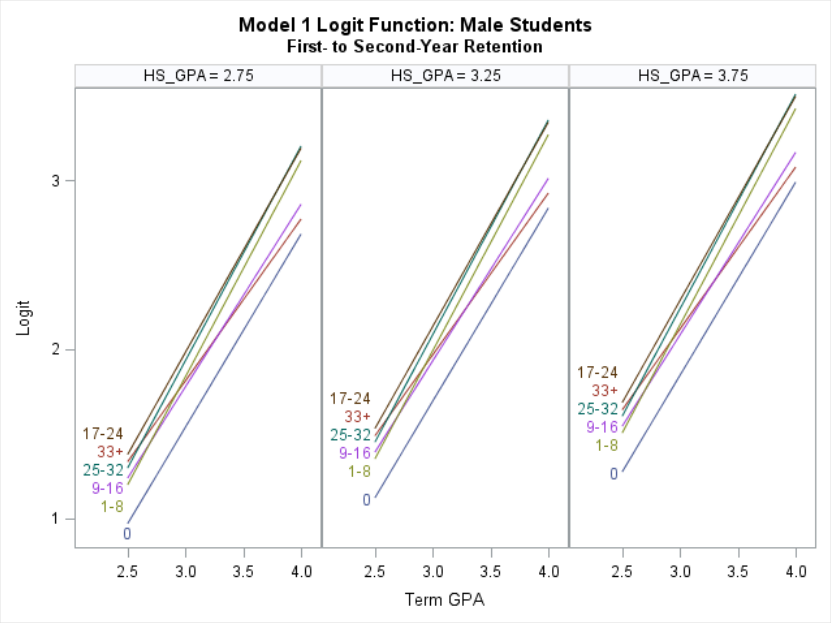

Figure 16. First- to Second-Year Retention Logit Plots (Male Students)

LS means estimates, which are provided in Table 12, were then calculated and pairwise comparisons, with the Tukey-Kramer adjustment, were conducted at three levels of term GPA; 2.50, 3.00, and 3.50. At a term GPA of 2.50, there is a statistically significant difference between '0' and '17-24' (p=0.0129), and '0' and '33+' (p=0.0102). The odds of retention for male students who had 17-24 visits to the REC facility and completed the term with a GPA of 2.50 were 1.507 times the odds of retention for male students who did not visit the REC facility and completed the term with a GPA of 2.50. Similarly, the odds of retention for male students who had 33 or more visits and completed the term with a GPA of 2.50 were 1.443 times the odds of retention for male students who did not visit the REC facility and completed the term with a 2.50 GPA. As the term GPA increases, the differences in the visit categories are statistically insignificant. There was only one borderline significant visit category comparison ('17-24' vs '0'; p-value 0.0510) between male students who completed the fall term with a GPA of 3.00.

There were no statistically significant differences between the groups when compared at a term GPA of 3.50.

Table 12. First- to Second-Year Visit Category Mean Comparisons (Male Students)

Differences of VCAT Least Squares Means (Tukey-Kramer Adjustment)							
VCAT	_VCAT	TERM_GPA	HS_GPA	Estimate	Standard Error	Adj. P	Odds Ratio
1-8	9-16	2.5	3.25	-0.03968	0.09571	0.9984	0.961
1-8	17-24	2.5	3.25	-0.1794	0.1094	0.5718	0.836
1-8	25-32	2.5	3.25	-0.09931	0.1249	0.9684	0.905
1-8	33+	2.5	3.25	-0.1361	0.09135	0.6707	0.873
1-8	0	2.5	3.25	0.2305	0.1038	0.2285	1.259
9-16	17-24	2.5	3.25	-0.1397	0.1179	0.8443	0.87
9-16	25-32	2.5	3.25	-0.05963	0.1324	0.9977	0.942
9-16	33+	2.5	3.25	-0.09643	0.1014	0.9331	0.908
9-16	0	2.5	3.25	0.2702	0.1128	0.1577	1.31
17-24	25-32	2.5	3.25	0.08005	0.1426	0.9934	1.083
17-24	33+	2.5	3.25	0.04324	0.1144	0.999	1.044
17-24	0	2.5	3.25	0.4099	0.1246	0.0129	1.507
25-32	33+	2.5	3.25	-0.03681	0.1293	0.9997	0.964
25-32	0	2.5	3.25	0.3298	0.1385	0.1625	1.391
33+	0	2.5	3.25	0.3666	0.1092	0.0102	1.443

An analogous first- to second-year retention analysis was performed for female students. Two models for female students were assessed. The first model includes the variables TERM_GPA ($p<.0001$), HS_GPA ($p=0.0165$), VCAT ($p=0.0336$), and TERM_GPA*VCAT (p-value=0.0917). The interaction term was left in this model as it was significant prior to the removal of HS_GPA*VCAT, which was insignificant in the model. The model with the interaction term will be compared to the model with only main effects. The test of fixed effects for these models are provided in Table 13, and fixed effect estimates and model comparisons are in Table 14. Both models retention predictions were 81% accurate, at a cutoff of 0.50.

Table 13. First- to Second-Year Retention Model Test of Fixed Effects (Female Students)

	Type III Tests of Fixed Effects			
	Model 1		Model 2	
Effect	F Value	p-value	F Value	p-value
TERM_GPA	303.24	<.0001	457.64	<.0001
HS_GPA	5.76	0.0165	4.56	0.0327
VCAT	2.42	0.0336	2.57	0.0251
TERM_GPA*VCAT	1.89	0.0917		

Table 14. First- to Second-Year Retention Model Estimates and Comparisons (Female Students)

Solutions for Fixed Effects and Model Comparisons			
Effect	VCAT	Model 1 Estimate	Model 2 Estimate
Intercept		-2.4038	-2.158
TERM_GPA		0.99	0.9243
HS_GPA		0.2096	0.1851
VCAT	1-8	0.1302	0.1843
VCAT	9-16	0.6455	0.2689
VCAT	17-24	0.5991	0.3819
VCAT	25-32	0.8864	0.3458
VCAT	33+	1.15	0.1554
VCAT	0		
TERM_GPA* VCAT	1-8	0.01939	
TERM_GPA* VCAT	9-16	-0.1447	
TERM_GPA* VCAT	17-24	-0.0851	
TERM_GPA* VCAT	25-32	-0.1956	
TERM_GPA* VCAT	33+	-0.3337	
TERM_GPA* VCAT	0	0	
Correct		80.92%	80.78%
False Positive		16.92%	17.12%
False Negative		2.18%	2.10%

The log odds as a function of term GPA from model 1 was plotted at three levels of high school GPA; 2.75, 3.25 and 3.75, which are provided in Figure 17. In general, the slopes of the visit categories appear to be parallel, with the exception of the '33+' group. Female students who do not visit the REC facility have a clear separation from the other visit categories at lower term GPAs.

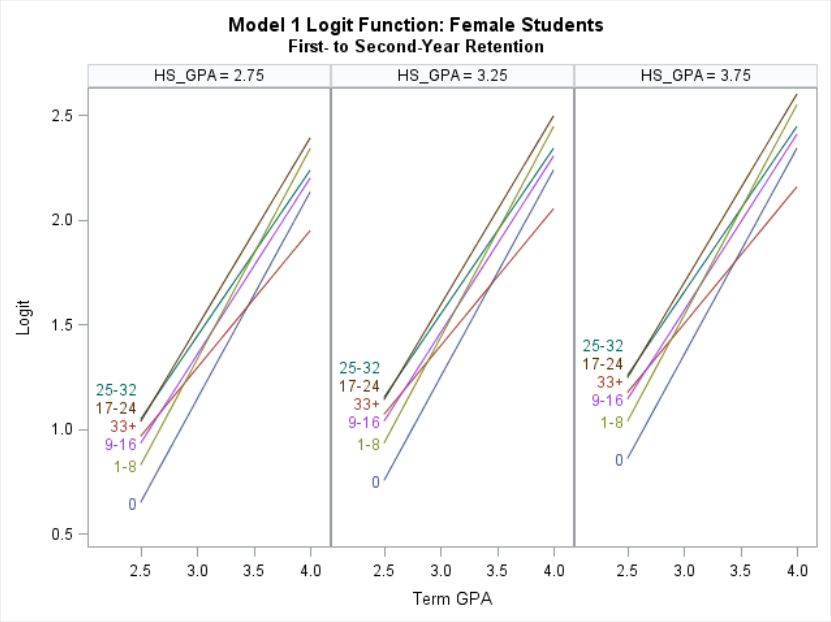

Figure 17. First- to Second-Year Retention Logit Plots (Female Students)

LS means estimates were then calculated and pairwise comparisons, with the Tukey-Kramer adjustment, were conducted at three levels of term GPA; 2.50, 3.00, and 3.50. At a term GPA of 2.50, the only statistically significant difference is between visit categories '0' and '17-24' (p=0.0386). The odds of retention for female students who had 17-24 visits to the REC facility and completed the term with a GPA of 2.50 were 1.472 times the odds of retention for female students who did not visit the REC facility and completed the term with a GPA of 2.50. As the term GPA increases, the differences in the visit categories are statistically insignificant.

There were no significant differences between the groups when compared at term GPAs 3.00 and 3.50.

First- to Third-Year Retention

Next, first- to third-year retention rates were compared. A student was considered retained from the first- to third-year if they were enrolled for credit as of the institution's census enrollment date in the second fall semester following their first fall term of enrollment. For example, a student in the Fall 2008 first-year cohort was considered retained if they were enrolled as of census date in the Fall 2010 term. Retention rates by visit category for male and female students are provided in Tables 15 and 16, respectively. As with first- to second-year retention rates, there is an evident increasing trend as REC visit category increases. Male students who had at least 33 visits to the REC facility their first fall term had a retention rate of 77.35%, compared to 55.23% for those who did not visit the REC facility. Female students had similar outcomes with 75.60% of students in the '33+' visit category retained, compared to 54.69% of those who did not visit the REC facility.

Table 15. First- to Third-Year Retention Rates by Visit Category (Male Students)

VCAT	Retained		
	No	Yes	Total Headcount
0	44.77 %	55.23 %	976
1-8	38.98 %	61.02 %	2,142
9-16	34.92 %	65.08 %	1,280
17-24	28.90 %	71.10 %	962
25-32	28.59 %	71.41 %	668
33+	22.65 %	77.35 %	1,647
Overall	*33.37 %*	*66.63 %*	*7,765*

Table 16. First- to Third-Year Retention Rates by Visit Category (Female Students)

VCAT	Retained		
	No	Yes	Total Headcount
0	45.31 %	54.69 %	885
1-8	39.53 %	60.47 %	2,168
9-16	33.14 %	66.86 %	1,219
17-24	27.43 %	72.57 %	773
25-32	24.69 %	75.31 %	482
33+	24.40 %	75.60 %	963
Overall	*34.33 %*	*65.67 %*	*6,490*

Again, a generalized linear mixed model with a Binary distribution and Logit link function with a random cohort effect was conducted to compare the first- to third- retention rates over the six visit categories. Male students were analyzed first, followed by female students.

The model chosen to analyze male students consisted of all variables that were found be significant at the 0.05 alpha level, which includes TERM_GPA, HS_GPA, VCAT, TERM_GPA*VCAT, and HS_GPA*VCAT. The test of fixed effects are provided in Table 17, and fixed effect estimates are in Table 18.

Table 17. First- to Third-Year Retention Model Test of Fixed Effects (Male Students)

	Type III Tests of Fixed Effects	
Effect	F Value	p-value
TERM_GPA	667.30	<.0001
HS_GPA	64.90	<.0001
VCAT	0.80	0.5464
TERM_GPA*VCAT	3.02	0.01
HS_GPA*VCAT	2.64	0.0217

Table 18. First- to Third-Year Retention Model Estimates (Male Students)

Solutions for Fixed Effects and Model Comparisons		
Effect	VCAT	Estimate
Intercept		-4.1669
TERM_GPA		1.352
HS_GPA		0.3341
VCAT	1-8	0.01081
VCAT	9-16	-0.1524
VCAT	17-24	-1.1706
VCAT	25-32	-1.1461
VCAT	33+	-0.5255
VCAT	0	0
TERM_GPA* VCAT	1-8	-0.01812
TERM_GPA* VCAT	9-16	0.03072
TERM_GPA* VCAT	17-24	-0.08739
TERM_GPA* VCAT	25-32	-0.1094
TERM_GPA* VCAT	33+	-0.4507
TERM_GPA* VCAT	0	0
HS_GPA* VCAT	1-8	0.07525
HS_GPA* VCAT	9-16	0.1037
HS_GPA* VCAT	17-24	0.5754
HS_GPA* VCAT	25-32	0.542
HS_GPA* VCAT	33+	0.6866
HS_GPA* VCAT	0	0
Correct		78.15%
False Positive		15.95%
False Negative		5.90%

The logit estimates from the model were used to plot three levels of high school GPA: 2.75, 3.25 and 3.75; and three levels of term GPA: 2.50, 3.00, and 3.50. These plots are provided in Figures 18 and 19, respectively. In Figure 18, all visit categories, with the exception of '33 +', appear to have similar slopes. There is not as large of a separation between male students

who did not visit the REC facility and those who did when compared to the first- to second-year retention plots. The visit categories appear to be clumped in two groups in Figure 19. Male students who had between 0 and 16 visits have similar slopes, and male students who had 17 or more visits have similar slopes. At all three levels of term GPA, the first- to third-year retention rate for male students who had 16 or fewer visits appears to increase more slowly as high school GPA increases compared to students with more visits.

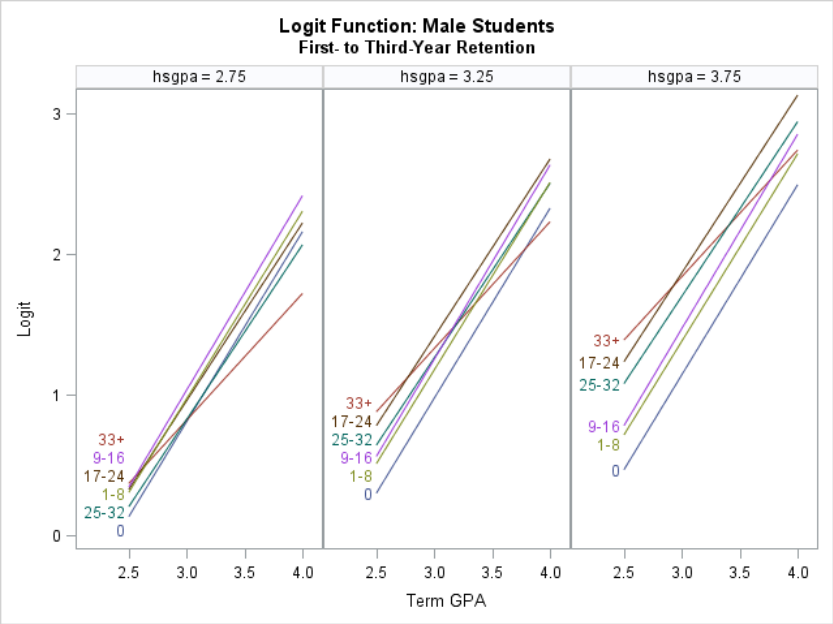

Figure 18. First- to Third-Year Retention Logit Plots by Term GPA (Male Students)

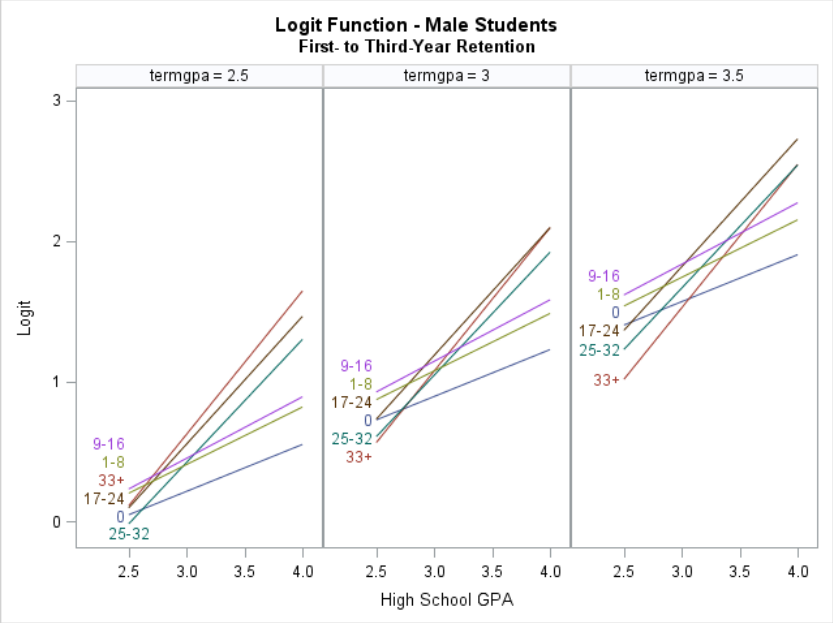

Figure 19. First- to Third-Year Retention Logit Plots by High School GPA (Male Students)

Pairwise comparisons, with the Tukey-Kramer adjustment, were then conducted at the various high school GPA and term GPA levels. The significant results, at alpha level 0.05, are provided in Table 19. As expected based on the plots, there were no significant differences at high school GPA 2.75, regardless of the term GPA. The largest statistically significant visit category differences for the various term and high school GPA combinations are highlighted in Table 19. The largest difference among all comparisons was between students with a term GPA of 2.50 and a high school GPA of 3.75. The odds of retention for male students who had 33 or more visits to the REC facility were 2.5 times the odds of retention for male students who did not visit the REC facility.

Table 19. First- to Third-Year Visit Category Mean Comparisons (Male Students)

Differences of VCAT Least Squares Means (Tukey-Kramer Adjustment)							
VCAT	_VCAT	TERM_GPA	HS_GPA	Estimate	Standard Error	Adj. P	Odds Ratio
33+	9-16	2.50	3.25	0.3180	0.09832	0.0155	1.374
33+	1-8	2.50	3.25	0.3693	0.08765	0.0004	1.447
17-24	0	2.50	3.25	0.4810	0.1189	0.0007	1.618
33+	0	2.50	3.25	0.5794	0.1074	<.0001	1.785
33+	0	3.00	3.25	0.3541	0.1221	0.0434	1.425
17-24	0	3.00	3.25	0.4373	0.1414	0.0243	1.549
17-24	1-8	2.50	3.75	0.5210	0.1705	0.0274	1.684
33+	9-16	2.50	3.75	0.6094	0.1655	0.0032	1.838
33+	1-8	2.50	3.75	0.6750	0.1488	<.0001	1.965
17-24	0	2.50	3.75	0.7687	0.1941	0.0011	2.157
33+	0	2.50	3.75	0.9227	0.1753	<.0001	2.516
33+	1-8	3.00	3.75	0.4588	0.1326	0.0072	1.582
17-24	1-8	3.00	3.75	0.4863	0.1615	0.0312	1.626
17-24	0	3.50	3.75	0.6813	0.2102	0.0152	1.976
33+	0	3.00	3.75	0.6974	0.1592	0.0002	2.009
17-24	0	3.00	3.75	0.7250	0.1839	0.0011	2.065

The analagous female first- to third-year retention rates were analyzed next. The variables found to be significant at the alpha level of 0.05 were TERM_GPA, HS_GPA, and VCAT. The test of fixed effects are provided in Table 20, and fixed effect estimates are in Table 21.

Table 20. First- to Third-Year Retention Model Test of Fixed Effects (Female Students)

	Type III Tests of Fixed Effects	
Effect	F Value	p-value
TERM_GPA	410.29	<.0001
HS_GPA	50.36	<.0001
VCAT	3.14	0.0078

Table 21. First- to Third-Year Retention Model Estimates (Female Students)

Solutions for Fixed Effects and Model Comparisons		
Effect	VCAT	Estimate
Intercept		-4.3042
TERM_GPA		0.9443
HS_GPA		0.6013
VCAT	1-8	0.1109
VCAT	9-16	0.2318
VCAT	17-24	0.322
VCAT	25-32	0.4398
VCAT	33+	0.2481
VCAT	0	0
Correct		72.98%
False Positive		20.49%
False Negative		6.43%

The logit estimates from the model were used to plot the log odds as a function of term GPA for each of the visit categories, which is shown in Figure 20. Interaction terms were insignificant, therefore, all visit categories are assumed to have the same slope. The visit categories are quite evenly spaced with the exception of '33+' and '9-16', which appear to be quite similar.

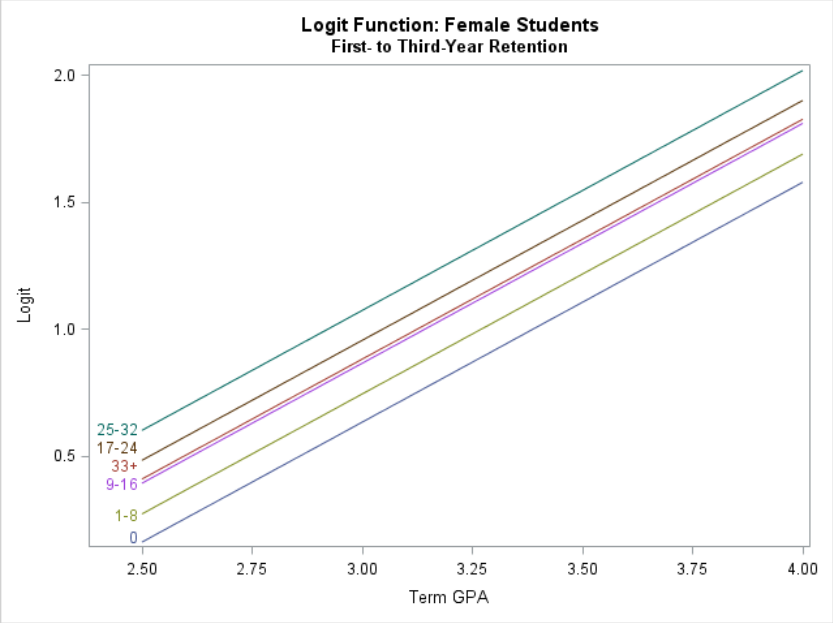

Figure 20. First- to Third-Year Retention Logit Plots (Female Students)

Next, using the Tukey-Kramer adjustment, pairwise comparisons were conducted to further assess differences in first- to third-year retention rates among the six visit categories. The only two visit categories identified as statistically signficantly different at the 0.05 alpha level were '25-32' and '0', with a p-value of 0.0214. The odds of first- to third-year retention for female students who had between 25 and 32 visits to the REC facility during their first fall semester were 1.55 times the odds of retention for female students who did not visit the REC facility.

Second- to Third-Year Retention

Lastly, second- to third-year retention rates were compared. Students who were retained to the second fall term were placed into a new REC facility visit category based upon their usage during their second fall term of enrollment. A student was considered retained from the second- to third-year if they were enrolled for credit as of the institution's census enrollment date in the second AND third fall semesters following their first fall term of enrollment. For example, a student in the Fall 2008 first-year cohort was considered retained if they were enrolled as of the

census date in the Fall 2009 term, and again in the Fall 2010 term. Students who were not retained to their second fall term were excluded from the analysis, regardless of their status during the third fall term. Second- to third-year retention rates by second-year visit category for male and female students are provided in Tables 22 and 23, respectively. For both male and female students, those who did not visit the REC facility during their second fall term had lower retention rates than those who did visit at least once, however, the differences among the groups is not as pronounced; especially when comparing the different visit categories for those students who did visit the REC facility.

Table 22. Second- to Third-Year Retention Rates by Second-Year Visit Category (Male)

VCAT	Retained		
	No	Yes	Total Headcount
0	23.44 %	76.56 %	1,694
1-8	16.92 %	83.08 %	1,761
9-16	16.42 %	83.58 %	749
17-24	13.57 %	86.43 %	479
25-32	14.05 %	85.95 %	370
33+	10.36 %	89.64 %	975
Overall	*17.19 %*	*82.81 %*	*6,028*

Table 23. Second- to Third-Year Retention Rates by Second-Year Visit Category (Female)

VCAT	Retained		
	No	Yes	Total Headcount
0	22.44 %	77.56 %	1,618
1-8	16.78 %	83.22 %	1,657
9-16	11.76 %	88.24 %	689
17-24	12.78 %	87.22 %	352
25-32	7.25 %	92.75 %	262
33+	9.32 %	90.68 %	429
Overall	*16.50 %*	*83.50 %*	*5,007*

A generalized linear mixed model with a Binary distribution and Logit link function and a random cohort effect was used to compare the second- to third-year retention rates over the six visit categories. As in all prior analyses, male students were analyzed first, followed by female students.

The model chosen to analyze male students consisted of all variables that were found be significant at the 0.05 alpha level, which includes second-year fall term GPA and visit category, as well as high school GPA. The test of fixed effects are provided in Table 24, and fixed effect estimates are in Table 25. The logit plot of the final model follows in Figure 21. Intuitively, visit categories '17-24' and '33+' are very similar and we would not expect to see a statistically significance difference between these two groups. Interestingly, the same can be said for visit categories '0' and '25-32'.

Table 24. Second- to Third-Year Retention Model Test of Fixed Effects (Male Students)

	Type III Tests of Fixed Effects	
Effect	F Value	p-value
TERM_GPA_YR2	692.15	<.0001
HS_GPA	57.25	<.0001
VCAT_YR2	2.46	0.0308

Table 25. Second- to Third-Year Retention Model Estimates (Male Students)

Solutions for Fixed Effects and Model Comparisons		
Effect	VCAT	Estimate
Intercept		-4.1639
TERM_GPA_YR2		1.2948
HS_GPA		0.7667
VCAT	1-8	0.1834
VCAT	9-16	0.05717
VCAT	17-24	0.3821
VCAT	25-32	0.05494
VCAT	33+	0.4227
VCAT	0	0
Correct		87.60 %
False Positive		10.07 %
False Negative		2.34 %

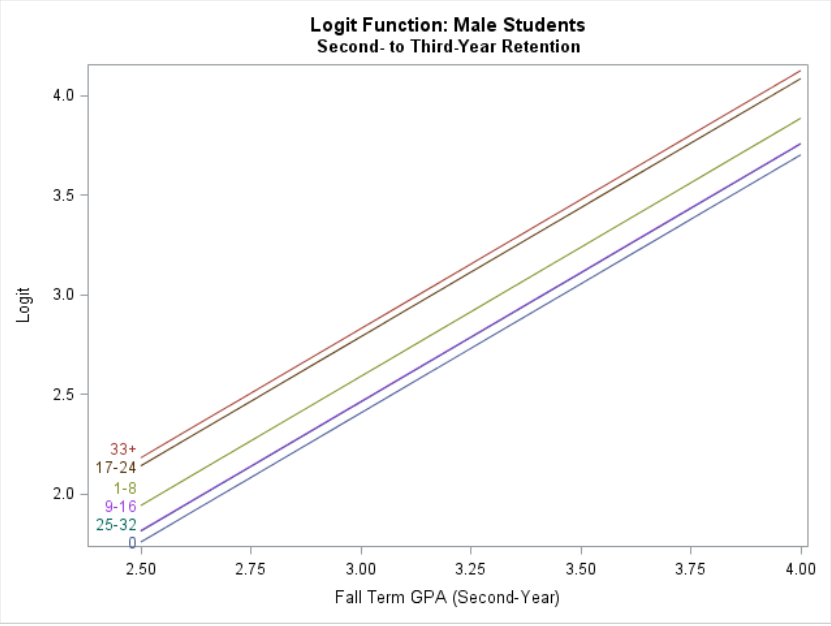

Figure 21. Second- to Third-Year Retention Logit Plots (Male Students)

Pairwise comparisons, using the Tukey-Kramer adjustment, were conducted to test for statistically signficant differences among the six visit categories. The only two visit categories

identified as statistically signficantly different at the 0.05 alpha level were ‘33+’ and ‘0’, with a p-value of 0.0360. The odds of second- to third-year retention for male students who had 33 or more visits to the REC facility during their second fall term were 1.526 times the odds for male students who did not visit the REC facility during their second fall term.

The variables included in the female second- to third-year retention model consisted of second-year fall term GPA and visit category, as well as high school GPA. All of these variables were statistically significantly different at the 0.05 alpha level. The test of fixed effects are provided in Table 26, and fixed effect estimates are in Table 27. The logit plot of the final model follows in Figure 22. Visit categories ‘9-16’ and ‘25-32’ appear to be very similar to one another, as well as groups ‘17-24’ and ‘33+’.

Table 26. Second- to Third-Year Retention Model Test of Fixed Effects (Female Students)

	Type III Tests of Fixed Effects	
Effect	F Value	p-value
TERM_GPA_YR2	394.33	<.0001
HS_GPA	18.25	<.0001
VCAT_YR2	2.76	0.0169

Table 27. Second- to Third-Year Retention Model Estimates (Female Students)

Solutions for Fixed Effects and Model Comparisons		
Effect	VCAT	Estimate
Intercept		-3.2631
TERM_GPA_YR2		1.1034
HS_GPA		0.5023
VCAT	1-8	0.1627
VCAT	9-16	0.4684
VCAT	17-24	0.3337
VCAT	25-32	0.5073
VCAT	33+	0.3121
VCAT	0	0
Correct		86.88 %
False Positive		11.54 %
False Negative		1.58 %

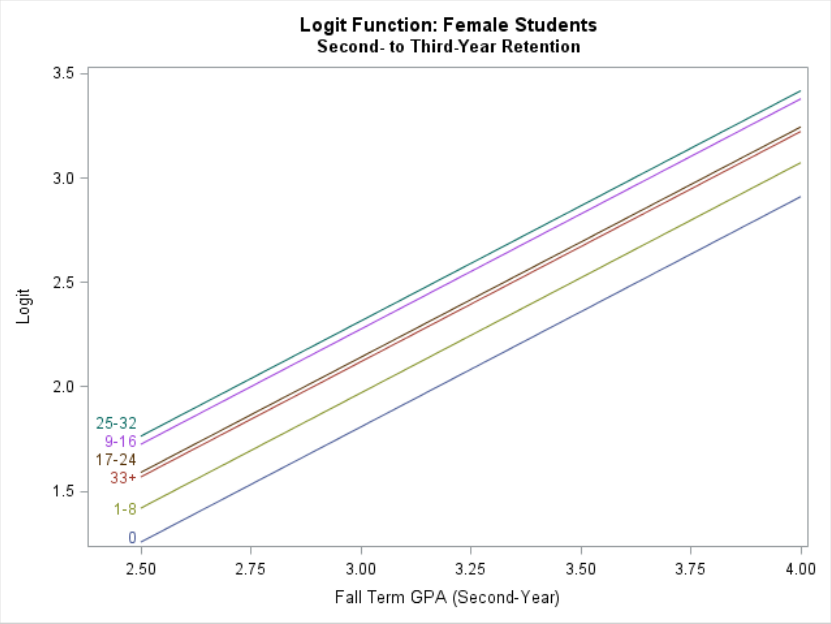

Figure 22. Second- to Third-Year Retention Logit Plots (Female Students)

Consistent with prior analyses, pairwise comparisons, using the Tukey-Kramer adjustment, were conducted to test for statistical signficance among the six visit categories. The only two visit categories identified as statistically signficantly different at the 0.05 alpha level were ‘9-16’ and ‘0’, with a p-value of 0.0223. The odds of second- to third-year retention for female students who had between 9 and 16 visits to the REC facility during their second fall term were 1.597 times the odds of retention for female students who did not visit the REC facility during their second fall term. Based on visual inspection of the logit plot, one would expect the ‘25-32’ visit category to be significantly different than ‘0’ if the category ‘9-16’ was significantly different. The standard error associated with the visit category ‘25-32’ is the largest of the six categories, and nearly twice as large as ‘9-16’. Even though the plot and parameter estimates suggest this group has the largest difference from those who did not visit the REC facility, there is a loss of power due to the amount of variation.

CONCLUSION

The purpose of this thesis was to examine the relationship between student academic outcomes and usage of the campus REC facility for first-time full-time degree seeking freshmen students. The results support prior research and theories, which suggest a positive association between student success and usage of the REC facility are present.

It was found that students who visited the REC facility during their first fall term entered the institution with a higher high school GPA than those who did not visit the REC facility. As the mean high school GPA of students increased the frequency of visits to the REC facility increased. ACT composite scores, however, were found to be very similar regardless of the number of visits to the REC facility.

In the analysis of first-term GPA it was found that, in general, as the visit frequency increased, so did the term GPA. As seen in Tukey-Kramer groupings in Table 6, there were statistically significant differences in term GPA of male students among the six visit categories, however, as the high school GPA increased the magnitude of the differences in term GPA decreased overall. Interestingly, for female students, as the high school GPA increased, the Tukey-Kramer groupings in Table 7 became more distinctive and, in general, the magnitude of the differences in term GPA among the six visit categories increased.

Statistically significant differences in retention rates were found among the visit categories, however, it is evident that term GPA plays a much larger role in predicting retention. As term GPA increased, the differences in first- to second-year retention rates among the visit categories became insignificant. There was significant interaction between term GPA, high school GPA and visit category in the first- to third-year retention rates for male students with the most notable statistical significant differences found at higher levels of high school GPA. The

differences were most evident for male students who did not visit the REC facility and those who visited 33 or more times. For female students, a statistically significant difference in first- to third-year retention rates was found between students who did not visit the REC facility, and those who had between 25 and 32 visits, regardless of term GPA. The final retention analyses found a statistically significant difference in second- to third-year retention rates for male students who did not visit the REC facility during their second fall term, compared to students who visited 33 or more times, regardless of term GPA. Interestingly, second- to third-year retention rates for female students who did not visit the REC facility and those in the '1-9' visit category were found to be statistically significantly different.

As with any analyses, there are limitations. There are numerous factors that influence a student's success; some can be measured, others cannot. Even if all measurable factors were included in the analyses, maintaining interpretability is a challenge. The results presented suggest an overall positive association between student success and REC facility usage, though this does not imply a cause and effect relationship. Academic variables, such as term GPA and high school GPA appear to be the most highly associated with student success and retention.

REFERENCES

ACT. (2015). Retrieved from http://www.act.org/

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of college student personnel, 25*(4), 297-308.

Belch, H. A., Gebel, M., & Maas, G. M. (2001). Relationship Between Student Recreation Complex Use, Academic Performance, and Persistence of First-Time Freshmen. *NASPA Journal, 38*(2), 254-268.

Centers for Disease Control and Prevention. (2015, June 4). *Physical Activity and Health*. Retrieved from http://www.cdc.gov/physicalactivity/basics/pa-health/

Henchy, A. (2011). The influence of campus recreation beyond the gym. *Recreational Sports Journal, 35*(2), 174-181.

Huesman Jr, R., Brown, A. K., Lee, G., Kellogg, J. P., & Radcliffe, P. M. (2009). Gym Bags and Mortarboards: Is Use of Campus Recreation Facilities Related to Student Success? *NASPA Journal, 46*(1), 50-71.

Kampf, S., & Teske, E. J. (2013). Collegiate Recreation Participation and Retention. *Recreational Sports Journal, 37*(2), 85-96.

Kramer, C. Y. (1956). Extension of Multiple Range Tests to Group Means with Unequal Numbers of Replications. *Biometrics, 12(3)*, 307-310. Retrieved from http://doi.org/10.2307/3001469

Lindsey, R., & Sessoms, E. (2006). Assessment of a campus recreation program on student recruitment, retention, and frequency of participation across certain demographic variables. *Recreational Sports Journal, 30*(1), 30-39.

Mayo Clinic. (2015). *Exercise and stress: Get moving to manage stress*. Retrieved from http://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/exercise-and-stress/art-20044469?pg=1

Miller, J. J. (2011). Impact of a university recreation center on social belonging and student retention. *Recreational Sports Journal, 35*(2), 117-129.

National Center for Education Statistics. (2015). *Integrated Postsecondary Edcucation Data System Glossary*. Retrieved from https://surveys.nces.ed.gov/ipeds/VisGlossaryAll.aspx

NCAA. (2015). *Student-Athlete Eligibility*. Retrieved from http://www.ncaa.org/about/student-athlete-eligibility

The Carnegie Classification of Institutions of Higher Education. (2015). Retrieved from The Carnegie Classification of Institutions of Higher Education: http://carnegieclassifications.iu.edu/classification_descriptions/size_setting.php

Tinto, V. (1975). Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research, 45*(1), 89-125.

Tinto, V. (1988). Stages of Student Departure: Reflections on the Longitudinal Character of Student Leaving. *The Journal of Higher Education, 59*(4), 438-455.

Tukey, J. W. (1952). The Problem of Multiple Comparisons. In H. I. Braun (Ed.), *The Collected Works of John W. Tukey* (Vol. 8). 1994, New York: Chapman & Hall.

Woodhouse, K. (2015, June 15). *Lazy Rivers and Student Debt*. Retrieved from Inside Higher Ed: https://www.insidehighered.com/news/2015/06/15/are-lazy-rivers-and-climbing-walls-driving-cost-college

Zizzi, S., Ayers, S. F., Watson II, J. C., & Keeler, L. (2004). Assessing the Impact of New Student Campus Recreation Centers. *NASPA Journal, 41*(4), 588-630.