The Value of Practical Experience

An Evaluation of the Success of FIRST Robotics Competition Participants in Higher Education

An Interactive Qualifying Project
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By

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Abstract

This study examines the relationship between FIRST Robotics Competition participation in high school and college performance with respect to quantifiable data such as GPAs, Dean's List, and standardized testing. The sample size was roughly 8,000 students, tracked across seven years. Only the classes of 2016 through 2018 had data indicating if they participated in FRC. Data was gathered through the Offices of Admissions and of the Registrar. Results showed that FIRST students did worse in college with respect to standard grading. Due to a lack of data on Team Projects no significant analysis was done on the effects of FIRST Participation on more design and build projects such as the IQP and MQP.

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Introduction

In today's world, STEM fields and those who work in them are becoming increasingly important. With so much of the future relying on technology, it is important that those who are creating it are well educated. This is the goal of FIRST: to stimulate interest in STEM fields from the elementary school level up through the high school level.

The purpose of this IQP was to carry out a study of the performance of FIRST Robotics alumni at a higher education institute. This was achieved by comparing the success of WPI students who participated in FIRST Robotics during high school against the success of students who did not. There is evidence that FIRST participation encourages students who do not perform as well in high-school as typical college applicants to apply for higher education anyway (Melchior, Cohen, Cutter, & Leavitt, 2005), and therefore the goal of this IQP is to research whether FIRST can be a factor in predicting academic performance in college.

Background

FIRST Robotics

FIRST Robotics (For Inspiration and Recognition of Science and Technology) is an organization whose purpose is to get primary and secondary school students interested in STEM Fields and, more generally, to encourage students to work together to solve problems by promoting "gracious professionalism" and "coopertition®" (FRC RSS, n.d.). For the purpose of this study, the scope is narrowed to FRC (FIRST Robotics Competition) alone, as more reliable data about participation on FRC teams is available compared to FTC or FLL teams. The particular event being focused on, FRC, is a large event where teams of students in high school are given the details of the particular year's competition six weeks before the mandatory end of the build season. The scope and objective of the competition change every season to promote constant innovation from new members. During these six weeks, students, led by volunteer mentors from their communities, are tasked with designing, constructing, and refining a robot from little more than scratch and a pool of some standardized parts. The pace of the competition necessitates that students work together and motivate themselves to learn a wide variety of skills to succeed. In this way, FIRST seeks to become an example to students of technical and scientific fields in a much more tangible way than the dry representations common to our culture, and to inspire interest in these fields when students apply to colleges. Additionally, regardless of where the participants choose to go after high school, FIRST aspires to instill gracious professionalism, "a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community," and a sense of coopertition, "...displaying unqualified kindness and respect in the face of fierce competition. Coopertition is founded on the concept and a philosophy that teams can and should help and cooperate with each other even as they compete." (FRC RSS, n.d.)

Worcester Polytechnic Institute

The philosophies of gracious professionalism and coopertition presented by FIRST are shared with WPI, not only in the attitudes passed on to students about professionalism, work ethic, and healthy competition, but also in the structure of the competition. Both WPI and FIRST are centered around short, highly concentrated, and team-based projects which focus on the practical application of skills as much as the theory behind design, and reward success in all aspects of the competition, from the most theoretical design to the most pragmatic solution. In a similar vein, there is a prevalent idea that a person's success and value are not so easily quantifiable as a GPA and list of awards, which are measurements only of how well one performs in class, as GPA can be too strongly affected by factors which do not affect success outside of classes.

As a way to allow students to show how skilled they are outside of normal classes, WPI has four major projects, three of which are required to graduate. The first project is optional and is done during the freshman year. The GPS, or Great Problems Seminar, is meant as an introduction to the project-based system of WPI. The GPS consists of a one term introduction and a one term project in which students pick something that they believe can be improved, then research and propose the solution they came up with. The next project is called the Inquiry Seminar and can be done at any time the student is in college. This project is optional however, as to complete the humanities requirement there are two main paths, and only one involves the Inquiry Seminar. This project focuses on the humanities and is a way for students to showcase what they have learned from the humanities classes they have taken.

The most well-known of these four projects are called the IQP and MQP. The IQP, or Interactive Qualifying Project, is usually done in the junior year and consists of a project that addresses issues in society. This project does not have to be related to the students major or field of study and is always done in teams. Some IQPs are done off-campus and involve coordinating with sponsors and advisers for a term followed by a term long intensive project working to solve the problem. Other IQPs are done on campus and typically involve three terms of work. The idea behind this project is to help the students

understand the practical effects of their work and simulate real-world research, and in turn make them better scientists and engineers.

The final project is usually done in the senior year and is called the MQP, or Major Qualifying Project. This project is designed to allow students to show what they have learned in their major field of study. It involves a team of students researching or designing something in their major field that can be applied to the real world. Examples of past MQPs are better mounts for snowboard boots that flex or break before the rider is hurt, robot networks for autonomous driving and prosthetics. An MQP usually takes three terms, although depending on the project it can take up to four. Some MQPs are done off campus in one term, but off campus MQPs are rare. The idea behind the MQP is to give students a chance to work on something real in their field of study while they still have the resources of WPI and the advice of the professors.

Literature Review

The subject being researched is not one that has been explored very thoroughly - the IQP Team found two papers that have conducted research into the topic of FIRST and how it relates to higher education. The first paper, "More than Robots: An Evaluation of the FIRST Robotics Competition Participant and Institutional Impacts" (Melchior, Cohen, Cutter, & Leavitt, 2005), was conducted by a team at Brandeis University in 2002: its primary conclusion was that FIRST alumni are significantly more likely to attend college and twice as likely to major in science and engineering[3]. The second paper, "Educational Effects of FIRST Robotics: An Evaluation of FIRST Robots' Impact at the College Level" (Goldberg, Kurzmack, & Slezycki, 2007), was an Interactive Qualifying Project at WPI in 2007 which conducted a study into the academic standing of FIRST alumni at WPI in order to determine the merit of acceptance of such students into the school.

Brandeis University Paper

In 2002, FIRST contracted Brandeis University to perform an analysis of FIRST Robotics, with the specific goals of determining 1) the impact of FIRST on academic and career trajectories, 2) the implementation of FIRST in schools, and 3) the impact of FIRST on participating schools and partnering organizations. Another key goal of the study was to focus specifically on "schools in urban communities and/or serving high proportions of low income and minority students." (Melchior, Cohen, Cutter, & Leavitt, 2005) Brandeis conducted a two-part study, the first of which was a survey of FIRST alumni concerning post high-school education, career experiences, and personal retrospective assessment of the participants' experience in FIRST. The second part of the study involved interviewing team representatives in 10 participating high schools concerning the implementation of the program and impact on participating schools. The study concluded that FIRST alumni had a higher-than-average college-going rate and were much more likely to pursue courses and careers in engineering or STEM fields.

Worcester Polytechnic Institute Paper

The 2007 WPI IQP report attempted to determine whether there was a correlation between participation in FIRST Robotics in high school and academic success in higher education. They conducted a survey of WPI students to determine whether a student was in FIRST and the status of their academic performance in college in terms of academic honors, participation in FIRST in college, scholar awards, negative academic standing, activity involvement, leadership positions, and personal student assessment of abilities. The team's conclusion stated that participation in FIRST should be a significant factor considered during the admissions process. However, the results of the paper were not considered significant because the sample size was small (62 students out of the roughly 3000 undergraduate students), and much of the data they were looking for had either no or limited availability from the offices of WPI.

Hypothesis

The IQP team hypothesized that FIRST alumni will perform better in college than a student with similar high school performance. This hypothesis was partially based on the research by Brandeis University, which puts forth that FIRST Robotics encourages students to apply to college even if the student's high school performance is lower than the average high school performance a school normally requires (Melchior, Cohen, Cutter, & Leavitt, 2005). This hypothesis was also founded on the assumption that WPI accepts students with a lower high school performance based on the fact that they participated in FIRST, as suggested by the previous IQP on this topic.

There are several reasons why the team assumed that FIRST Robotics would help a student perform better in college. The first was that students participating in a complicated and team-based project like the FIRST Robotics Competition will gain valuable insight and experience that will help them perform well in the project-based curriculum that WPI is centered around. Another reason for this hypothesis was that participating in FIRST Robotics might work much the same as learning a second language or learning how to play an instrument. Both these activities have been shown to expand the capabilities of and improve some of the functionalities of the brain which would likely be less strongly used like language and reasoning (Collins, 2014) (Mårtenssona, et al., 2012). This is similar to how participation in a build or design team would stimulate spatial reasoning, planning, and strategy which public schools do not offer. In addition to purely technical skills, FRC provides an opportunity to learn and build upon other skills that may work the same way, such as managerial, financial, and organizational skills.

Methodology

This study presents the possibility of three different outcomes. First, that there is no difference between those who participated in FIRST and those who didn't. Second, the data may not reach a significant conclusion. Third, FIRST alumni will either do noticeably better or worse than students who did not participate in FIRST.

The data used for this study was collected, combined, and anonymized by the WPI Offices of Undergraduate Admissions and Registrar. The types of data received for each anonymous student were:

- Type of degree
- Majors
- Minors (if any)
- Ethnicity
- Class year
- Gender
- International status
- Transfer credits
- WPI credits
- FIRST participation
- High school GPA and class rank
- SAT and ACT scores
- GPS participation and grade
- Dean's List status
- IQP participation and location
- MQP grade
- Degree(s) awarded
- Honors graduated with

The metrics of success that will be used for the college level are GPA, WPI Credits, and Dean's List. These are used exclusively because data on graduation, degrees awarded, and project grades are not available for students who have participated in FRC.

While this was an ideal source of information for this study, the sensitivity of the data required that it be kept anonymous. Maintaining anonymity is critical, so gathering further data was impossible; even if some students consented to give the IQP team their identity and information, process of elimination could allow the team to identify students who had not consented. This means that the information received from the offices of Admission and the Registrar was the only source of information for this study.

This data was also somewhat limited. The team only had very standardized numerical data which FRC Alumni was not expected to excel at, and the IQP Team could not interview individual students for more qualitative data. The data was also limited by the fact that the Office of Undergraduate Admissions has kept track of FRC participation starting with the class of 2016 (the junior class of WPI as of the time of this study), which reduces the expected number of FRC students who have completed their IQP to 50 and provides no data on FRC students' grades on MQPs. This dataset lacks information on projects and project-based courses, which FRC students are expected to favor more than traditional academic classes.

To analyze this data, the IQP team first had to determine how they would compare the data and what they would determine as statistically significant. They decided that a simple linear fit with certainty intervals would be the best way to analyze continuous and interval data, and ANOVA the best way to analyze categorical. ANOVA analysis is a way to test the variation of data across several categories to determine if the categories are affecting the dependent variable. Each analysis would differentiate between FIRST alumni and non-FIRST alumni. To visualize ANOVA analysis, box plots were generated to create a side-by-side comparison of data; to visualize regressions, trend lines and certainty intervals for FIRST and non-FIRST data were plotted on the same graph. The idea behind this method is that it would be easy to show general trends very clearly and in a way that is simple to compare. This would also allow the IQP team to share data in such a way that it will remain anonymous. The certainty intervals in linear

regression plots and box plots also made analysis easier, as it was easy to determine if a set of data overlaps or contains another and by how much. If certainty intervals in a plot share any values, then for the values they overlap, no significant conclusion can be reached.

After settling on what analysis to run, the IQP team had to figure out how to judge if the results were statistically significant or not. The desired level of certainty was agreed to be 95%. For that, the team used three numbers: the certainty interval, the f-test result and the p value. The certainty interval represents all possible trend lines that could exist given an arbitrary certainty value, and in this study certainty is 95% ($\alpha = 0.05$). By comparing the certainty of different sets of data, a conclusion can be reached to determine if the data is significant. The next number, the result of the f-test, can be used to test how similar two sets of data are. The critical f-statistic is calculated using the f-distribution for the degrees of freedom of the observation, degrees of freedom of the error, and the alpha value used in the analysis. If the f-value of a test is less than the critical f-statistic for that test, the test does not reach a significant conclusion for the alpha value given. The last number, the p value, is the probability that the null hypothesis is true, meaning that there is no correlation. If the p-value is less than the alpha value determined earlier, the correlation is significant. The actual analysis was done in MATLAB, using either the linearModel class for regressions, or the anova1/anova2/anovan function to generate the ANOVA tables.

In constructing the graphs, the IQP team first selected the datasets to analyze. In many cases they had to account for high school performance, so they knew that the data had to be compared against some metric of success from high school. For this, the team used ACT scores, SAT scores, high school GPA, and transfer credits. Once the set of variables to analyze were determined, the data had to be processed and changed into a useful form, and then the analysis was run. The regressions graphs were created using the standard plot function on both FIRST and non-FIRST datasets and displaying the results on the same set of axes. The individual data points were then removed. The plots for ANOVA analysis were box plots with notches included for an alpha of 0.05.

Results

The table below shows the correlations between all the variables analyzed.

	FRC	High School GPA	SAT	ACT	Transfer Credits
Term/WPI GPA	-0.07 const. p = 1.42e-05	1.31 intercept p = 2.44e-59 0.51 slope p = 1.39e-127	1.89 intercept p = 5.31e-260 7.47e-4 slope p = 3.30e-154	2.39 intercept p = 9.33e-206 0.0346 slope p = 3.29e-38	3.14 intercept p = 0 0.0189 slope p = 1.15e-279
Dean's List/term	insignificant p = 0.170	-0.558 intercept p = 2.63e-16 0.186 slope p = 1.04e-25	-0.391 intercept p = 4.62e-13 2.89e-4 slope p = 1.32e-24	-0.11intercept p = 0.151 0.00919 slope p = 4.77e-4	0.0889 intercept p = 4.45e-47 0.00788 slope p = 1.95e-54
WPI Credits	insignificant p = 0.0852	14.0 intercept p = 0.0981 5.1925 slope p = 0.0181	43.7 intercept p = 2.73e-13 -0.00489 slope p = 0.115	55.4 intercept p = 3.08e-10 -0.763 slope p = 0.00993	32.5 intercept p = 0 0.143 slope p = 0.0133

Table 1 *Significance and relation between high school and college metrics of success*

What follows is the results from the data analysis. Each section of the results corresponds to a dataset that was analyzed and consists of a short description of what the graph or table means. A short description of the significance of each dataset and the conclusion of the analysis is also provided. A final analysis of all the datasets and what the individual conclusions state about what effect FIRST has on college performance is in the discussion section that follows.

The α for all statistical analysis is 0.05, which defines a certainty interval of 95%. The degrees of freedom for all analysis is 1, with the exception of majors, as shown in every statistics table in Appendix B. For the data to be statistically significant, the F-statistic must therefore be greater than 3.8416. All sections have a corresponding subsection in Appendix B containing relevant figures and statistical data.

Decline in GPA Over the Years

There has been a steady decline in GPA at WPI over the past 7 years. Whatever the reason, comparisons between years must account for this change.

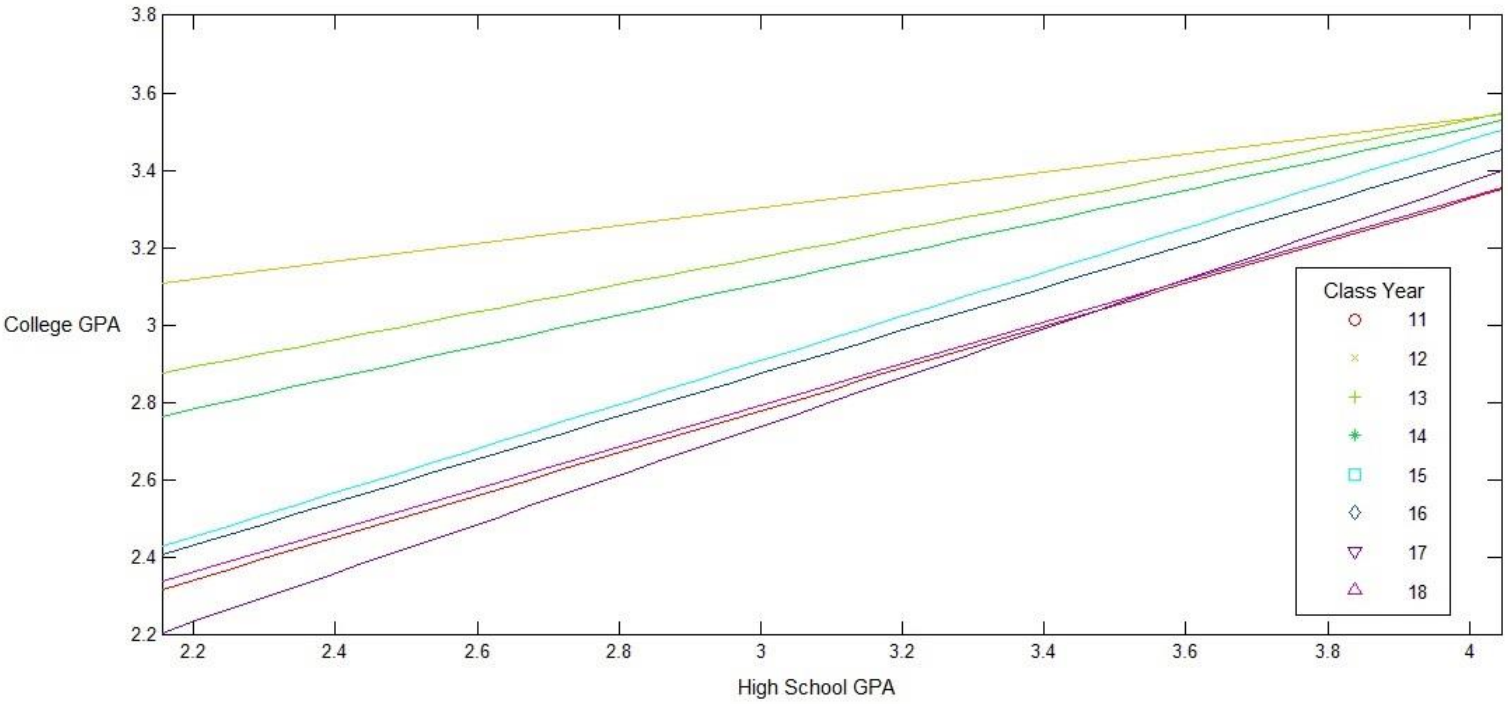

Figure 1 *College GPA vs High School GPA for all students for the past seven years*

High School Credentials Individual Analysis

SAT

SAT scores between the FIRST students and the non-FIRST students for the three years that contain FIRST participation data were compared using an ANOVA analysis. FIRST students tend to have a higher average score for their Math and Writing SAT scores and a much higher average for their Critical Reading SAT. This trend is expressed in Figure 2, which shows the composite SAT scores for FIRST and non-FIRST students. It should also be noted that the starting points of the bottom 25th percentile and of the middle 50th percentile in all cases are higher up for the FIRST group than that of the non-FIRST group. Table 2 shows that FIRST participation has a positive correlation with SAT scores.

Figure 3 shows that despite higher performance on SATs, FIRST students tend to have a lower WPI GPA. However, this trend only holds up until an SAT score of 2100, where FIRST and non-FIRST students start to perform similarly in college in terms of GPA. Lower-scoring FIRST students are more likely to have a lower college GPA than lower-scoring non-FIRST students.

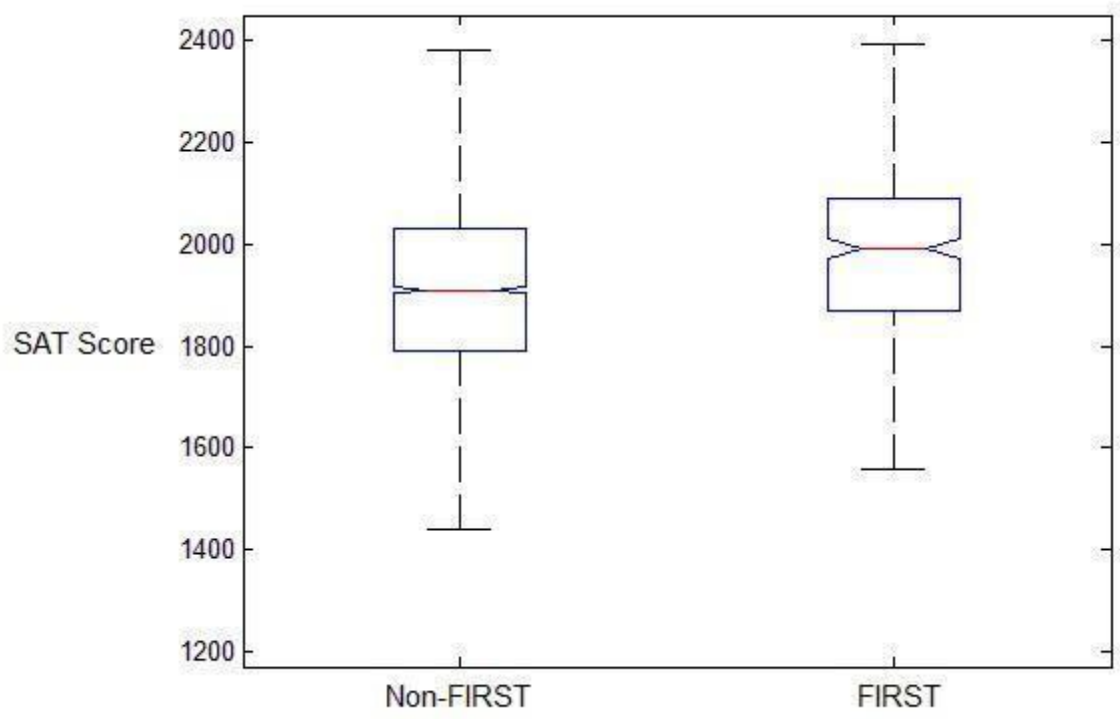

Figure 2 *SAT Composite Scores for FIRST and non-FIRST*

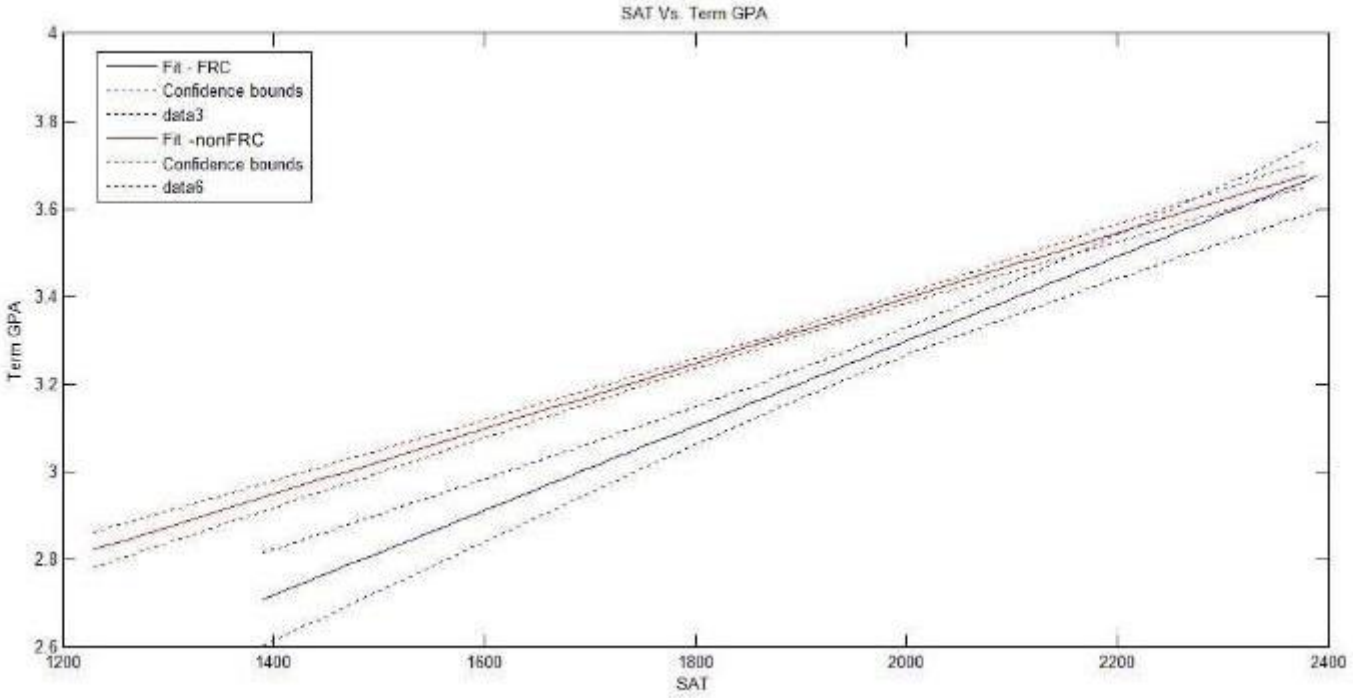

Figure 3 *SAT Composite Scores vs. College GPA for FIRST and non-FIRST*

	F-statistic	p-value
SAT Math	9.28	0.0023
SAT Writing	11.5	0.0007
SAT Critical Reading	73.46	1.71186e-17
SAT Composite	42.76	7.38606e-11

Table 2 *F-statistic and p-value based on SAT scores and FIRST participation. Since all F-statistics are > 3.8416 and the p-values are within acceptable range, the analysis is significant*

ACT

The differences between FIRST and non-FIRST students on their ACT scores are not as defined as the SAT results. The average scores for FIRST students are the same as non-FIRST students, and the middle 50th percentile is also relatively equal. Figure 4 shows the relationship between college GPA and composite ACT scores for every student. The overlapping and width of the confidence intervals, along with the results in Table 3, show that FIRST participation is not significantly related to ACT scores.

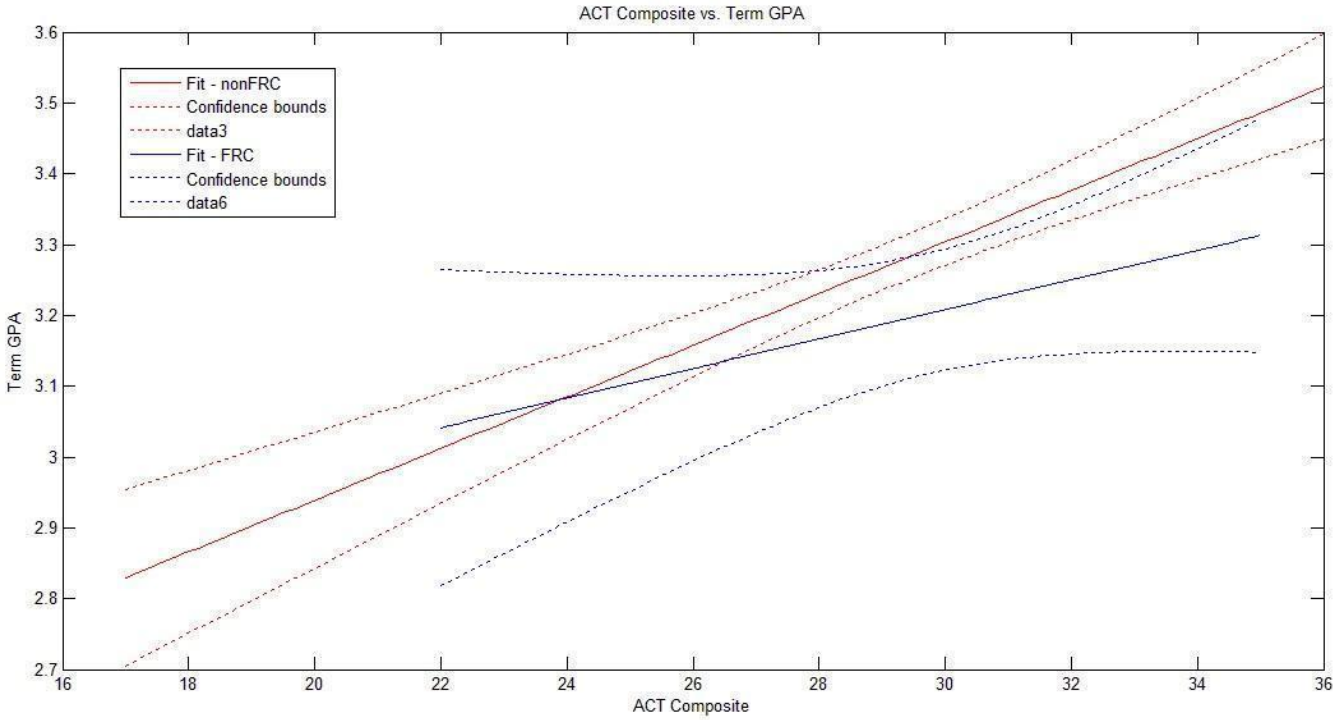

Figure 4 *ACT Composite Scores vs. College GPA for FIRST and non-FIRST*

	F-statistic	p-value
ACT Writing	3.65	0.0564
ACT Math	0.08	0.7737
ACT Reading	1.62	0.2028
ACT SS	3.61	0.0579
ACT Verbal	0.49	0.4862
ACT Composite	3.65	0.0564

Table 3 *F-statistic and p-value based on ACT scores and FIRST participation. Since all F-statistics are < 3.8416 and all p-values are > 0.05, the relationship is insignificant.*

GPA

High School GPA is harder to analyze since a very high concentration of students came to WPI with a 4.0 in high school. The Office of Undergraduate Admissions scales the high school GPA they receive such that the GPA is on a four point scale and reflects the quality of the school. Most GPAs are a perfect 4.0 because a four point scale does not allow values above 4.0, so many are corrected upwards to that limit. The results from the anova analysis show that with an F-statistic of 0.24 and a p-value of 0.6228, FRC participation has no significant effect on high school GPA.

However, when comparing Term GPA and high school GPA for FIRST and non-FIRST students, high school GPA has a significant effect, which is seen in Figures 5 and 6 below. Figure 5 includes all seven years of data, but to account for the decline in GPA over the past several years, the term GPA vs. HS GPA was also calculated solely for classes of 2016 and on (Figure 6). There is an overall trend of FIRST students performing worse in terms of college GPA than non-FIRST students with the same high school GPA, but the gap narrows significantly when comparing FIRST students only within their class years. Another aspect of this analysis is that the higher performing students are in high school, the more likely that FIRST participation has no effect on college performance. In other words, higher high school-performing FIRST and non-FIRST students do very similarly in college in terms of GPA.

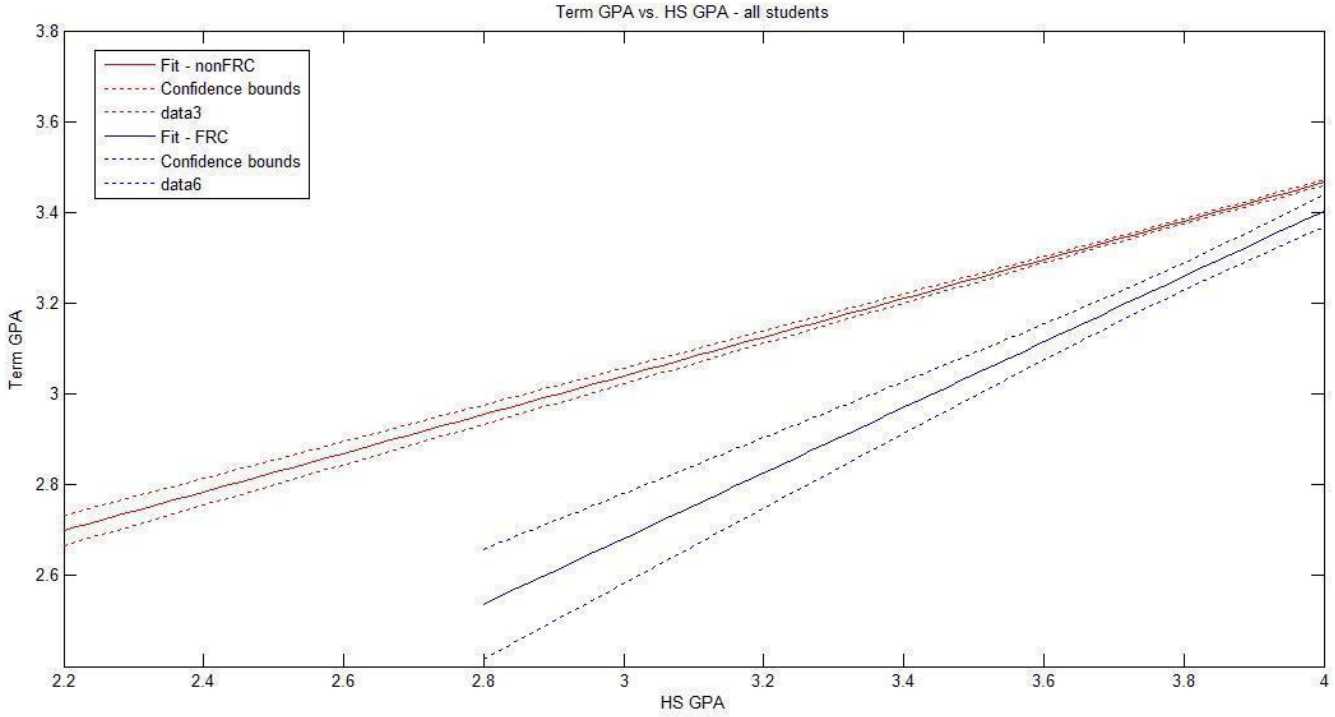

Figure 5 *High School GPA vs. College GPA for all seven years of data*

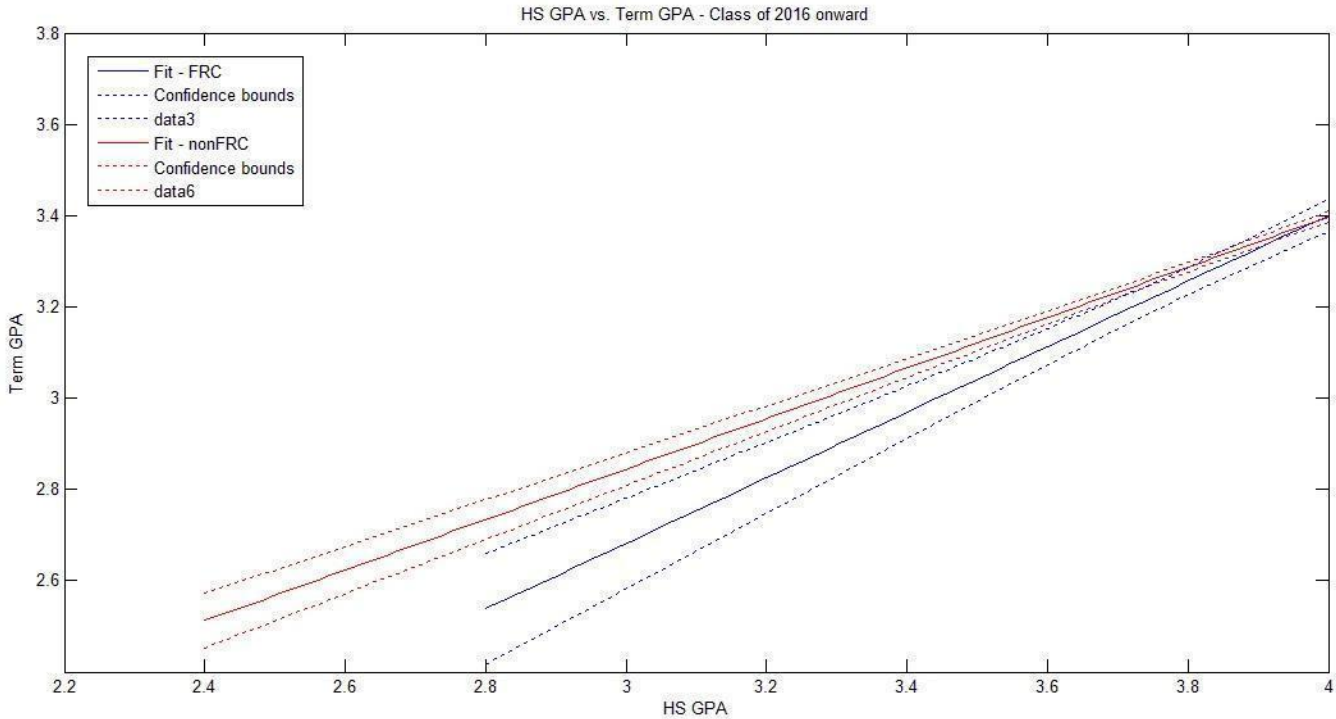

Figure 6 *High School GPA vs. College GPA for Class of 2016 onward*

College Credentials Individual Analysis

WPI Credits

Based on data from the Classes of 2016 and 2017, FIRST and non-FIRST students tend to accumulate the same amount of WPI credits per semester. Table 4 shows that there is no significant relationship between FRC participation and number of WPI credits.

	F-statistic	p-value
WPI Credits Class of 2016	0.65	0.4214
WPI Credits Class of 2017	0.92	0.3379

Table 4 *F-statistic and p-value based on FIRST and non-FIRST earned class credits at WPI. Since the F-statistics are < 3.8416 and all p-values are > 0.05, the relationship is insignificant.*

Dean's List

Since the number of times someone can be on the Dean's List is cumulative, only data for the Class of 2016 was looked at as the 1-3 semesters that the Classes of 2017 and 2018 have recorded is not a sufficient sample size. However, the F-statistic of 1.89 and p-value of 0.1696 renders the relationship statistically insignificant.

GPS

FIRST and non-FIRST students performed the same in the GPS course on average, and the relationship between them is statistically insignificant with an F-statistic of 0.13 and a p-value of 0.7163.

GPA

Separating the cumulative GPA for each class shows that the average GPA for FIRST students in comparison to the average GPA for non-FIRST students is even for the Class of 2018 (currently

freshman), a little lower for the Class of 2017 (currently sophomores), and even lower for the Class of 2016 (currently juniors). A similar result is seen when comparing the freshman, sophomore, and junior year GPAs for the Class of 2016, shown in Figure 7. FIRST students start out performing similarly to non-FIRST students, as expected given the relatively basic and standard courses of freshman year, but worsen comparatively as time goes on. After the fourth term, the certainty of the fit of the FIRST line widens as the sample size becomes much smaller. This implies that FIRST students do worse than their peers after their first semester, but after their fourth semester no significant conclusions can be drawn.

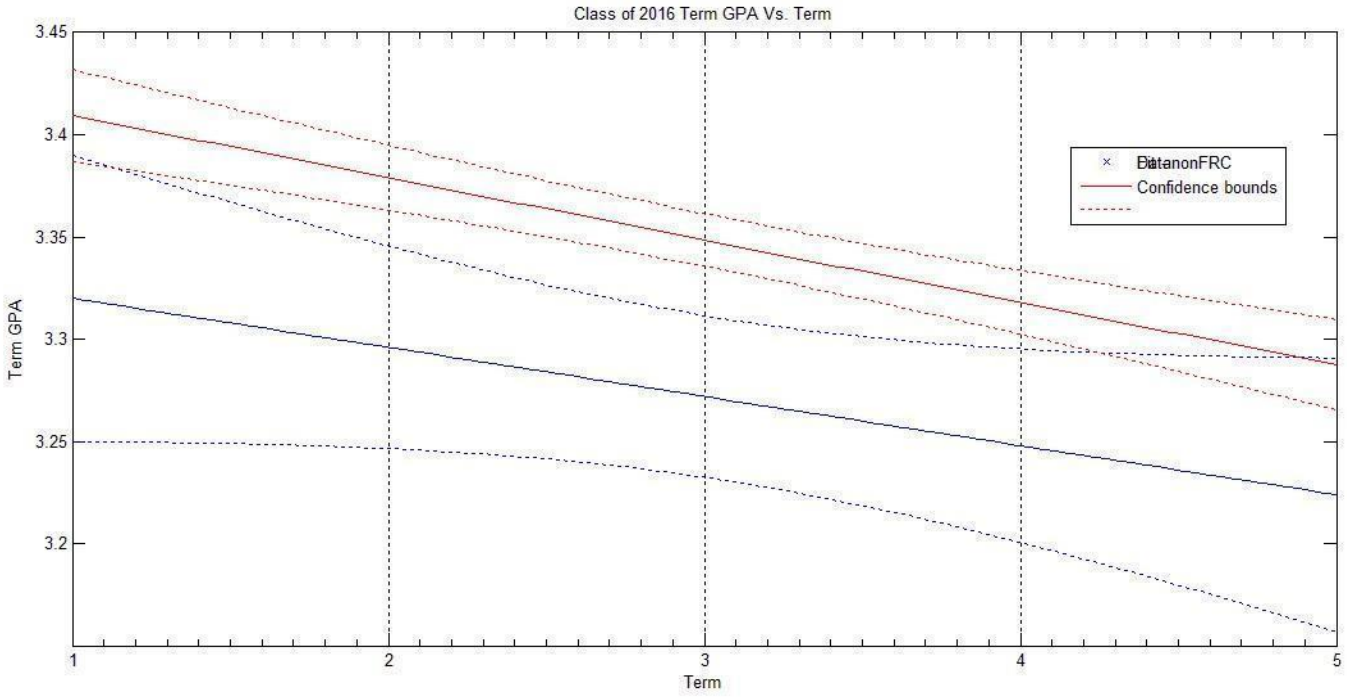

Figure 7 *GPA across semesters for Class of 2016 for FIRST and non-FIRST*

Discussion

The main conclusion to be drawn from this study is that FIRST alumni perform worse in college and better in high school than non-FIRST alumni. When running multiple linear regressions on high school GPA vs college GPA and looking at FIRST participation as a categorical variable, the p-value is approximately 0.28. However, when you also look at major as a categorical variable, the p-value increase to .87, which means that there is a much greater chance of the null hypothesis being true and that when correcting for major, FRC participation has no effect, though this may be due to the fact that each group is very small. After correcting for the major of the individuals, there was no significant difference between the FIRST and non-FIRST alumni grades. However, there is not enough data for every major to make the analysis statistically significant for every major, and therefore there is not enough data to make a general statement about WPI as a whole. This suggests that the different distribution of majors among FIRST students will affect the average GPA, but our sample size was too small to come to any significant conclusion.

The original hypothesis was that FIRST alumni will perform better in college than non-FIRST students with similar high school performance, and that the same FIRST student will perform worse in high school overall. However, this hypothesis was incorrect. The results show that while FIRST students do slightly better in high school, they do worse in college. There are several possible explanations for this. The first possible reason for this is that FIRST teams may have a support system in place for their team members. As a FIRST member a student would have mentors from college who may help the students out with homework or classes. Some FIRST teams may also have tutoring sessions for their students in order to make sure that the students' grades don't slip due to the intensive build season, and that may help the FIRST students' high school performance. When coming to college the FIRST alumni lose that support network, and after the first set of easier freshman year classes they may find it harder to maintain good grades without the support they had through high school. The next possible explanation is that some schools may encourage FIRST participants to spend time working on FIRST-related activities

by having the teachers go easier on FIRST participants. When these students get to college they now have to work just as hard on classes as everyone else, and as they are not used to this they end up doing worse. The final possible reason is that the FIRST alumni only went into FIRST because their parents pushed them to, in the same way that their parents pushed them to do very well in high school. After coming to college, they would not have their parents continually making sure they do well and would inevitably let their grades start to slip. All of these could explain why a FIRST alumni's High School GPA would be higher than average despite a lower college performance.

Conclusion

From the limited data used in this study, the conclusion is that FIRST has a small but statistically significant impact on college performance. While FIRST alumni do better in high school they do worse in college. However, this conclusion does not take into account many project-based classes in which FIRST are expected to excel, nor are there enough FIRST students to properly analyze the effect of declared majors on performance, so this study should be re-visited when that data is available.

Future Studies

The suggestions for a study to be done in the future involve waiting until there is enough data to track several classes with FIRST participation data through their entire college career. This will allow the next group to study whether or not FIRST alumni do better in project-based classes such as the IQP and MQP. It is expected that FIRST alumni will do better in these type of classes but the team was unable to prove this, so a third IQP is recommended. A third IQP would also allow for the study of FIRST and non-FIRST graduation rates and the honors level each type of student graduated with. A third IQP would also provide a sample size large enough to analyze the effects of major and FRC participation on GPA and other factors. It may also be worth focusing more on a thorough interview-based study to determine how well FIRST students felt they performed in normal classes and project-based classes based on their experience in FIRST.

Appendices

Appendix A: References

Collins, A. (2014). *How playing an instrument benefits your brain*. Retrieved from TEDEd: http://ed.ted.com/lessons/how-playing-an-instrument-benefits-your-brain-anita-collins

FRC RSS. (n.d.). *Gracious Professionalism*. Retrieved from US FIRST: http://www.usfirst.org/aboutus/gracious-professionalism

Goldberg, E., Kurzmack, W., & Slezycki, M. (2007). *Educational Effects of FIRST Robotics: An Evaluation of FIRST Robots' Impact at the College Level.* Worcester Polytechnic Institute.

Mårtenssona, J., Eriksson, J., Bodammer, N. C., Lindgren, M., Johansson, M., Nyberg, L., & Lövdén, M. (2012). *Growth of language-related brain areas after foreign language learning.* Lund University, Department of Psychology. Elsevier Inc.

Melchior, A., Cohen, F., Cutter, T., & Leavitt, T. (2005). *More than Robots: An Evaluation of the FIRST Robotics Competition Participant and Institutional Impacts.* Brandeis University, Waltham, MA Center for Youth and Communities, Heller School for Social Policy and Management.

Appendix B: Figures and Tables

SAT

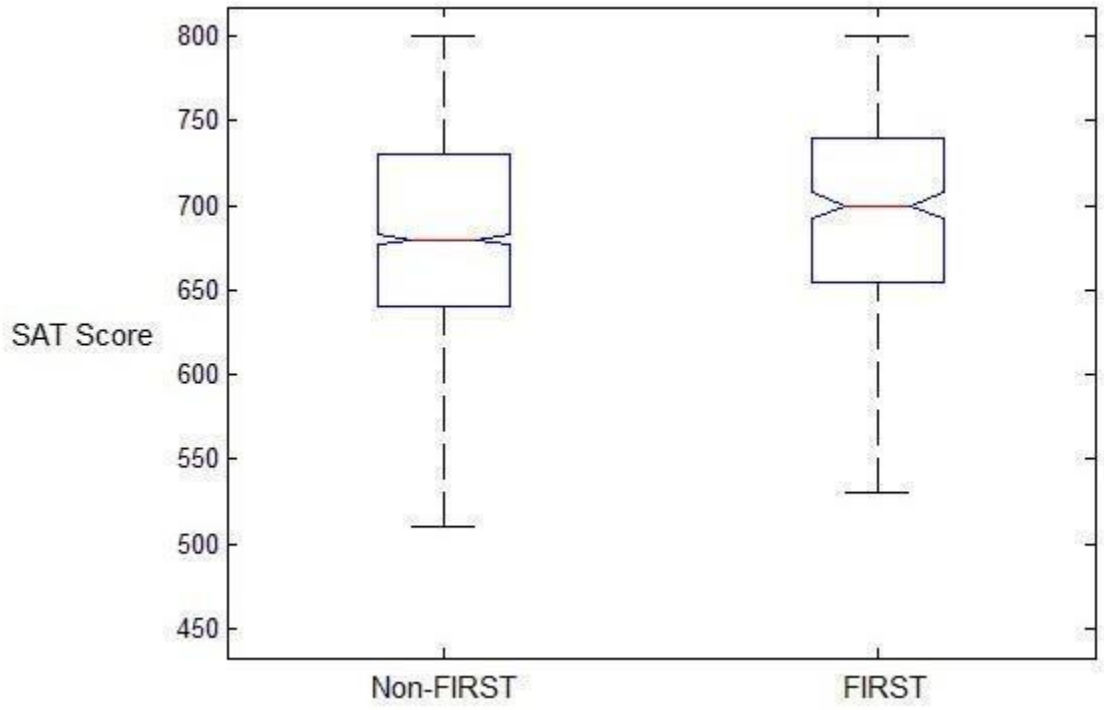

Figure 8 *SAT Math Scores for FIRST and non-FIRST*

MATH	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	696.37	64.193	683.75	65.922	685.09	65.844
Class_of_2016	690.5	66.597	677.62	63.821	678.84	64.159
Class_of_2017	696.37	64.193	686.72	68.902	687.98	68.386
Class_of_2018	696.37	64.193	683.75	65.922	685.09	65.844

Source	SS	df	MS	F	Prob>F
Groups	40120.98	1	40120.98	9.28	0.0023
Error	11506027.63	2662	4322.32		
Total	11546148.61	2663			

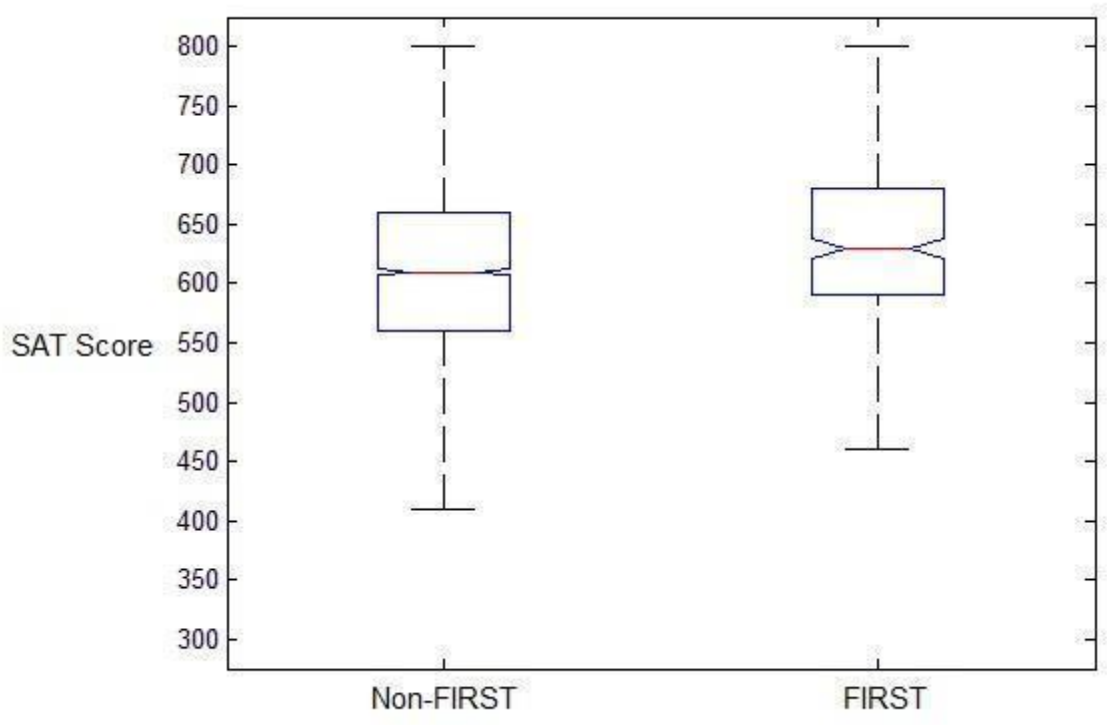

Figure 9 *SAT Writing Scores for FIRST and non-FIRST*

WR	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	629.82	73.294	613.55	76.781	615.29	76.569
Class_of_2016	626.13	73.113	608.34	77.014	610.02	76.788
Class_of_2017	629.82	73.294	615.3	80.228	617.49	79.07
Class_of_2018	629.82	73.294	613.55	76.781	615.29	76.569

Source	SS	df	MS	F	Prob>F
Groups	67158.3	1	67158.3	11.5	0.0007
Error	15545419.1	2662	5839.8		
Total	15612577.4	2663			

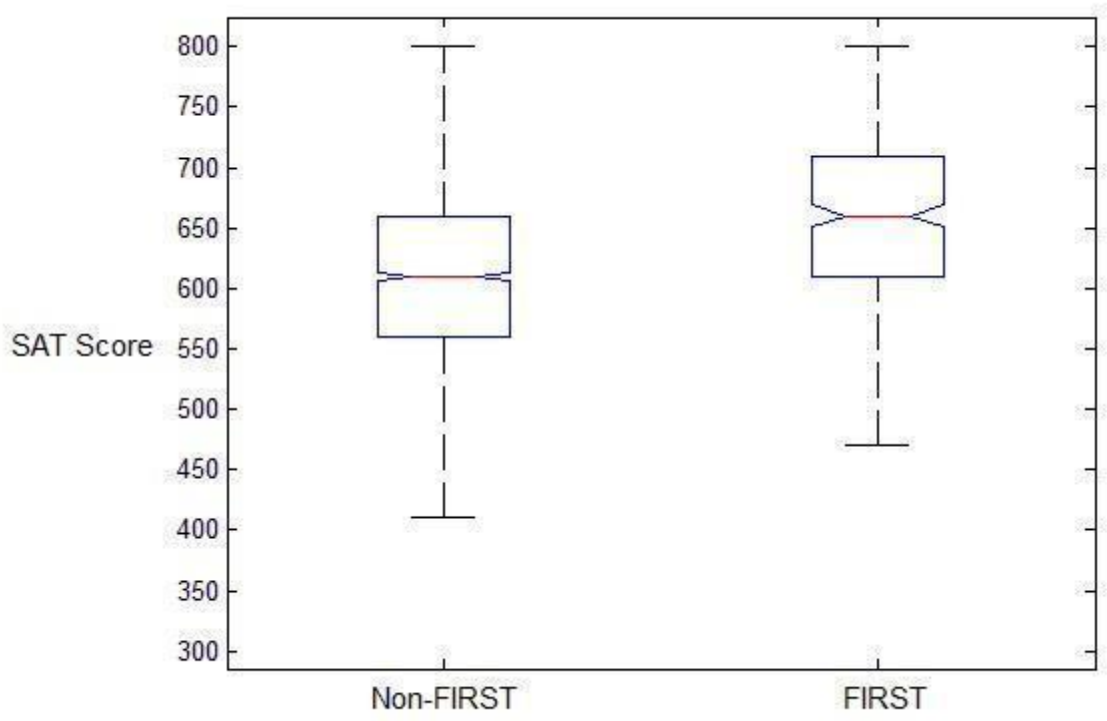

Figure 10 *SAT Critical Reading Scores for FIRST and non-FIRST*

CR	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	654.15	76.002	609.83	82.988	614.55	83.388
Class_of_2016	646.38	83.427	606.03	84.696	609.85	85.35
Class_of_2017	654.15	76.002	609.99	84.727	615.87	84.986
Class_of_2018	654.15	76.002	609.83	82.988	614.55	83.388

Source	SS	df	MS	F	Prob>F
Groups	495899.1	1	495899.1	73.46	1.71186e-17
Error	17969990.1	2662	6750.6		
Total	18465889.2	2663			

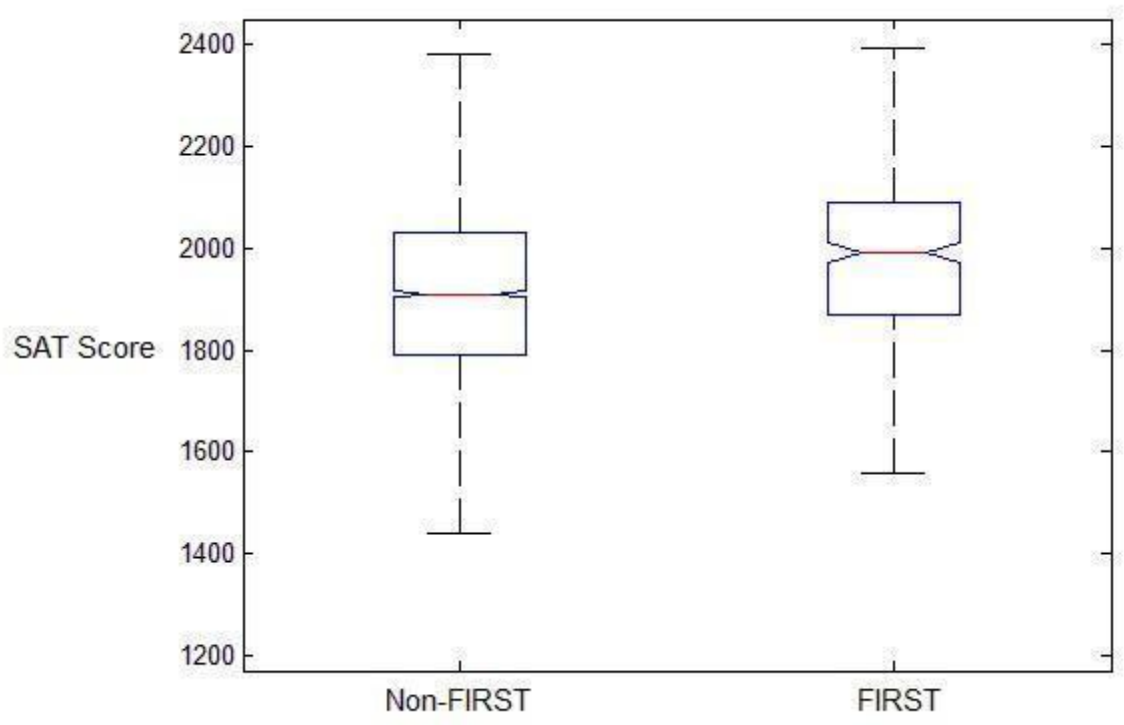

Figure 11 *SAT Composite Scores for FIRST and non-FIRST*

Total	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	1980.4	177.14	1907.3	178.04	1915.1	179.34
Class_of_2016	1963	184.89	1892.5	177.05	1899.2	178.89
Class_of_2017	1980.4	177.14	1912	186.44	1921.3	186.47
Class_of_2018	1980.4	177.14	1907.3	178.04	1915.1	179.34

Source	SS	df	MS	F	Prob>F
Groups	1.35409e+06	1	1354087.2	42.76	7.38606e-11
Error	8.42945e+07	2662	31665.9		
Total	8.56486e+07	2663			

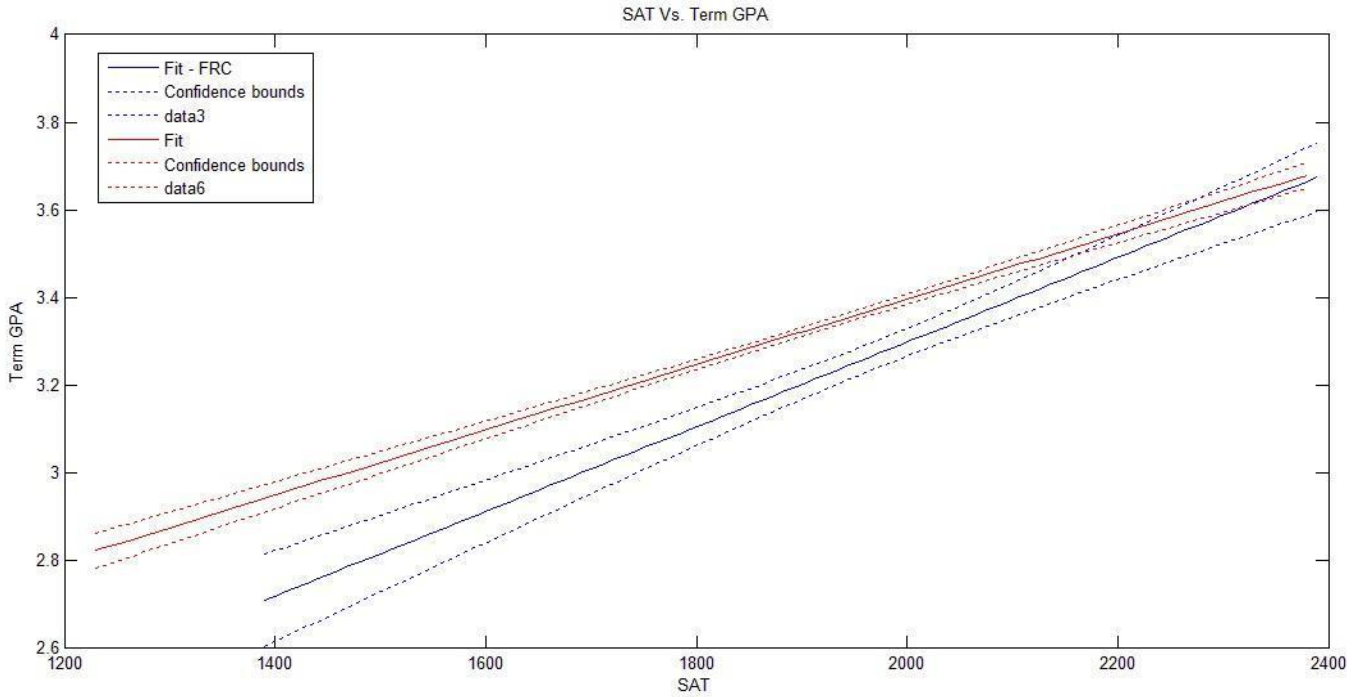

Figure 12 *SAT Composite Scores vs. College GPA for FIRST and non-FIRST*

FRC:
Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	1.3688	0.17422	7.8567	1.0565e-14
x1	0.00096484	8.791e-05	10.975	1.7638e-26

Number of observations: 959, Error degrees of freedom: 957
Root Mean Squared Error: 0.495
R-squared: 0.112, Adjusted R-Squared 0.111
F-statistic vs. constant model: 120, p-value = 1.76e-26

nonFRC:
Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	1.9073	0.056118	33.987	2.4835e-237
x1	0.00074465	2.9351e-05	25.37	7.0173e-137

Number of observations: 8391, Error degrees of freedom: 8389
Root Mean Squared Error: 0.478
R-squared: 0.0713, Adjusted R-Squared 0.0711
F-statistic vs. constant model: 644, p-value = 7.02e-137

ACT

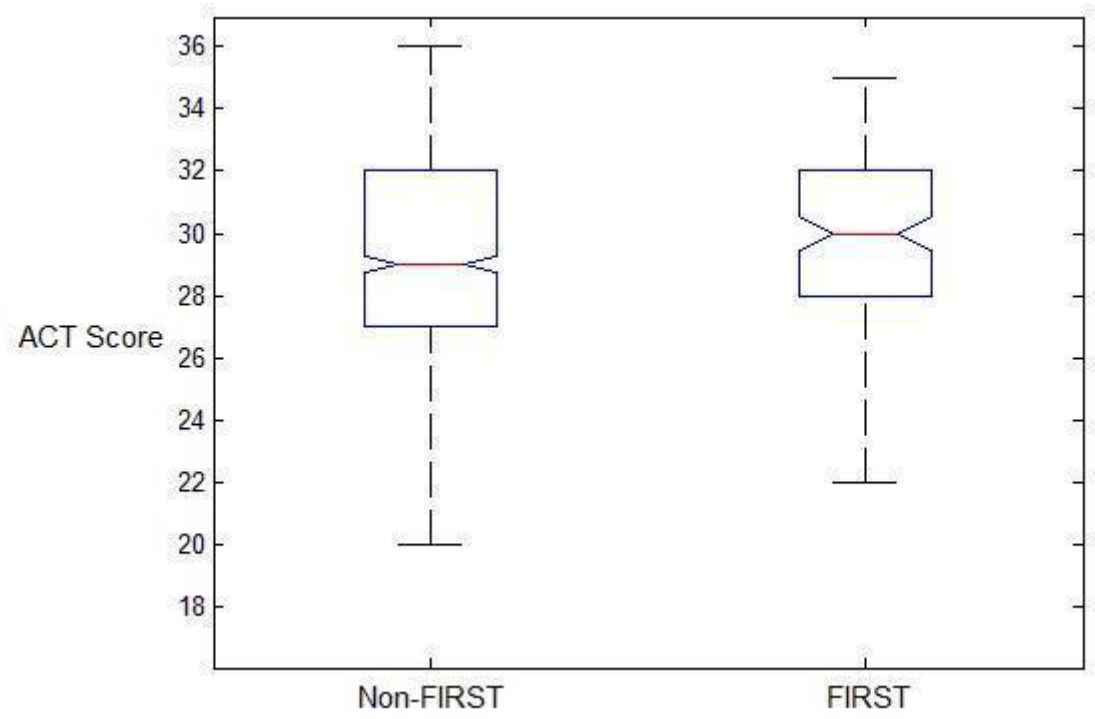

Figure 13 *ACT Writing Scores for FIRST and non-FIRST*

Combined Writing	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	26.874	3.3853	27.024	3.4397	27	3.4293
Class_of_2016	26.375	3.7994	26.761	3.5837	26.708	3.608
Class_of_2017	26.874	3.3853	26.848	3.3897	26.842	3.3757
Class_of_2018	26.874	3.3853	27.024	3.4397	27	3.4293

Source	SS	df	MS	F	Prob>F
Groups	38.35	1	38.3513	3.65	0.0564
Error	9755.36	928	10.5122		
Total	9793.72	929			

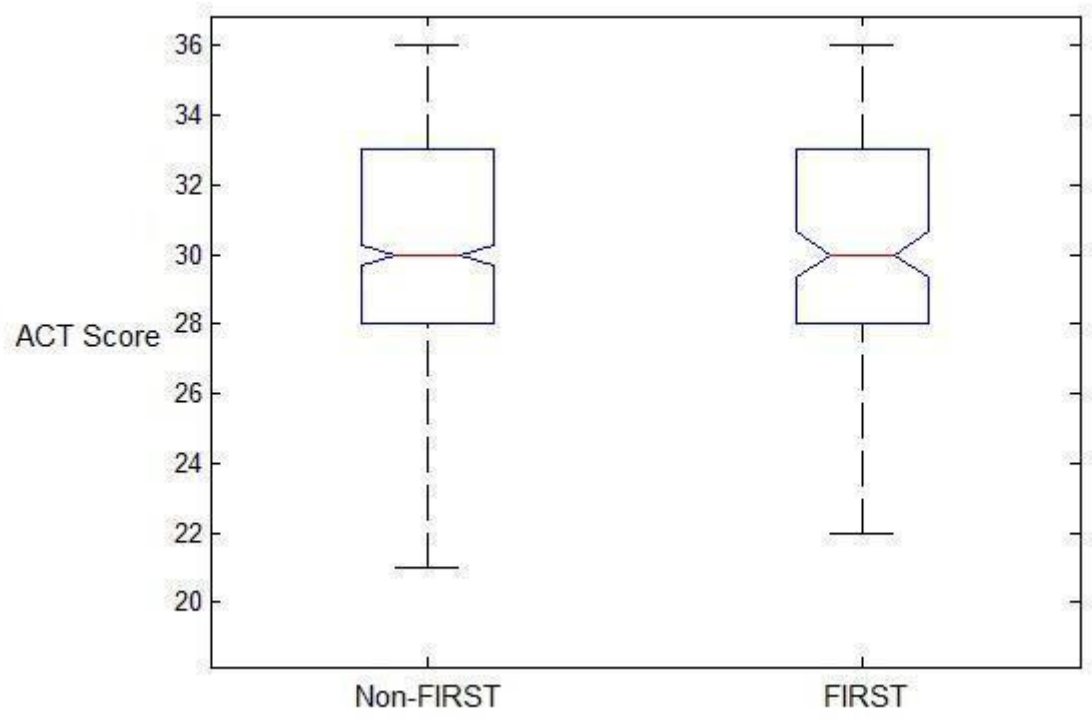

Figure 14 *ACT Math Scores for FIRST and non-FIRST*

Math	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	30.307	3.4376	30.198	3.2913	30.215	3.3127
Class_of_2016	29.257	4.0681	30.065	3.3015	29.958	3.4148
Class_of_2017	30.307	3.4376	29.988	3.3735	30.057	3.3599
Class_of_2018	30.307	3.4376	30.198	3.2913	30.215	3.3127

Source	SS	df	MS	F	Prob>F
Groups	0.91	1	0.9089	0.08	0.7737
Error	9637.73	877	10.9894		
Total	9638.64	878			

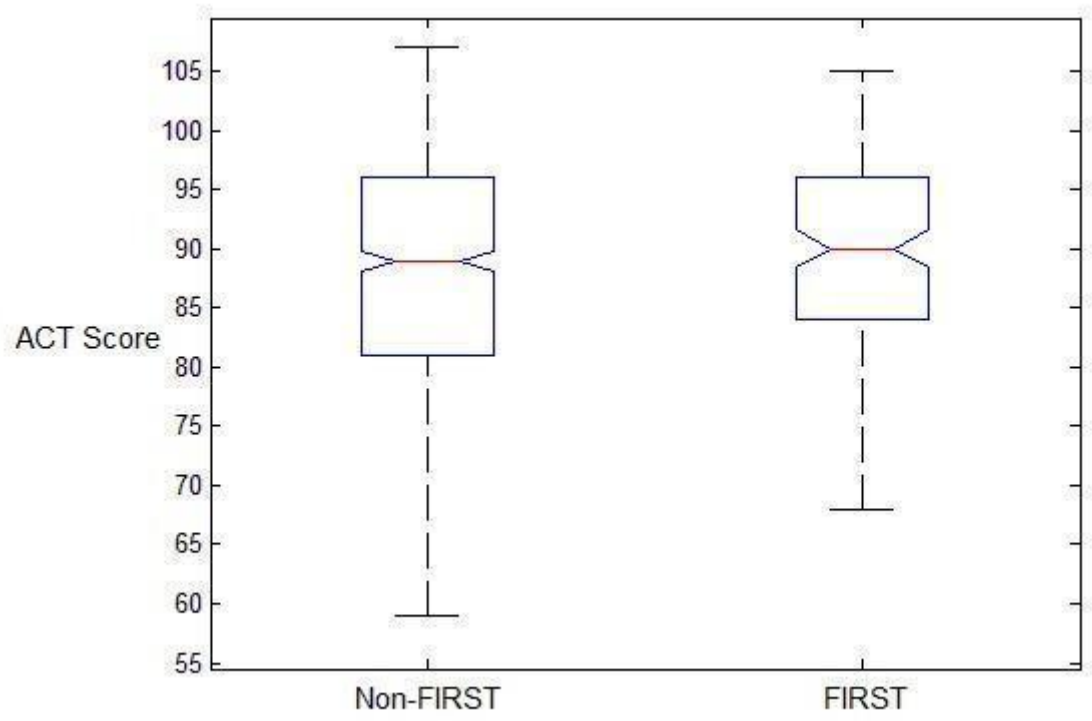

Figure 15 *ACT Reading Scores for FIRST and non-FIRST*

Reading	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	30.103	4.2883	29.324	4.5504	29.444	4.5174
Class_of_2016	28.457	4.7238	29.082	4.6408	29	4.6476
Class_of_2017	30.103	4.2883	29.399	4.5026	29.585	4.4483
Class_of_2018	30.103	4.2883	29.324	4.5504	29.444	4.5174

Source	SS	df	MS	F	Prob>F
Groups	151.3	1	151.263	1.62	0.2028
Error	81651.2	877	93.103		
Total	81802.5	878			

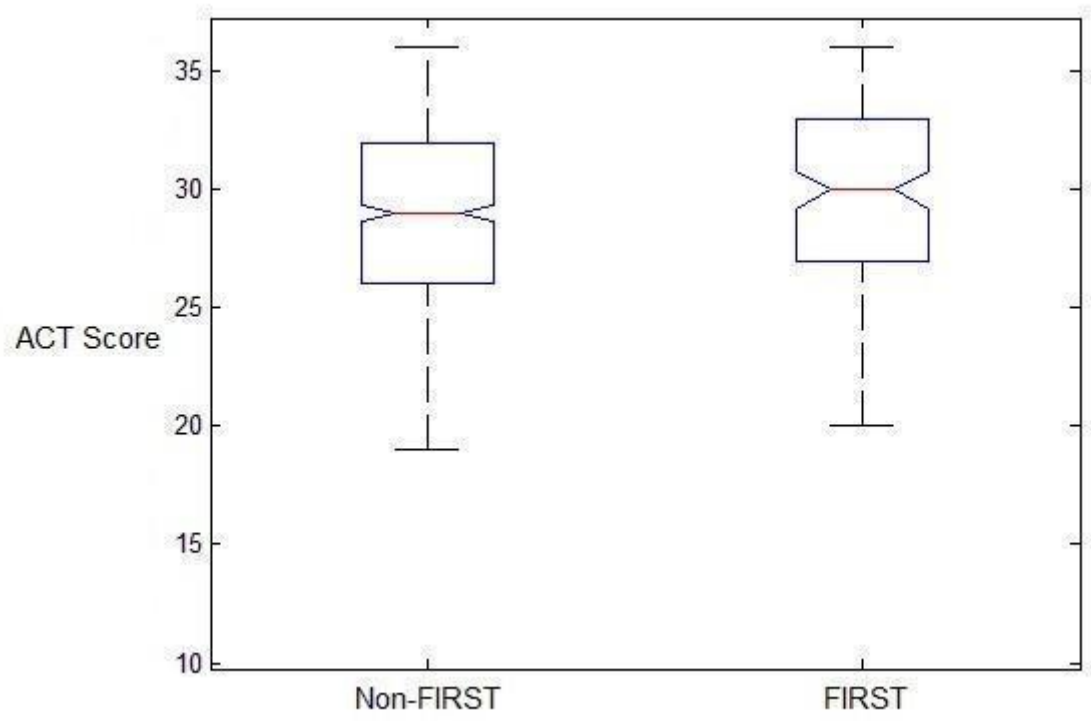

Figure 16 *ACT SS Scores for FIRST and non-FIRST*

SS	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	29.993	4.1824	29.215	4.1918	29.336	4.1975
Class_of_2016	29.057	4.7647	28.797	3.9812	28.831	4.0837
Class_of_2017	29.993	4.1824	29.137	4.0729	29.324	4.0812
Class_of_2018	29.993	4.1824	29.215	4.1918	29.336	4.1975

Source	SS	df	MS	F	Prob>F
Groups	63.2	1	63.1658	3.61	0.0579
Error	15364.7	877	17.5196		
Total	15427.9	878			

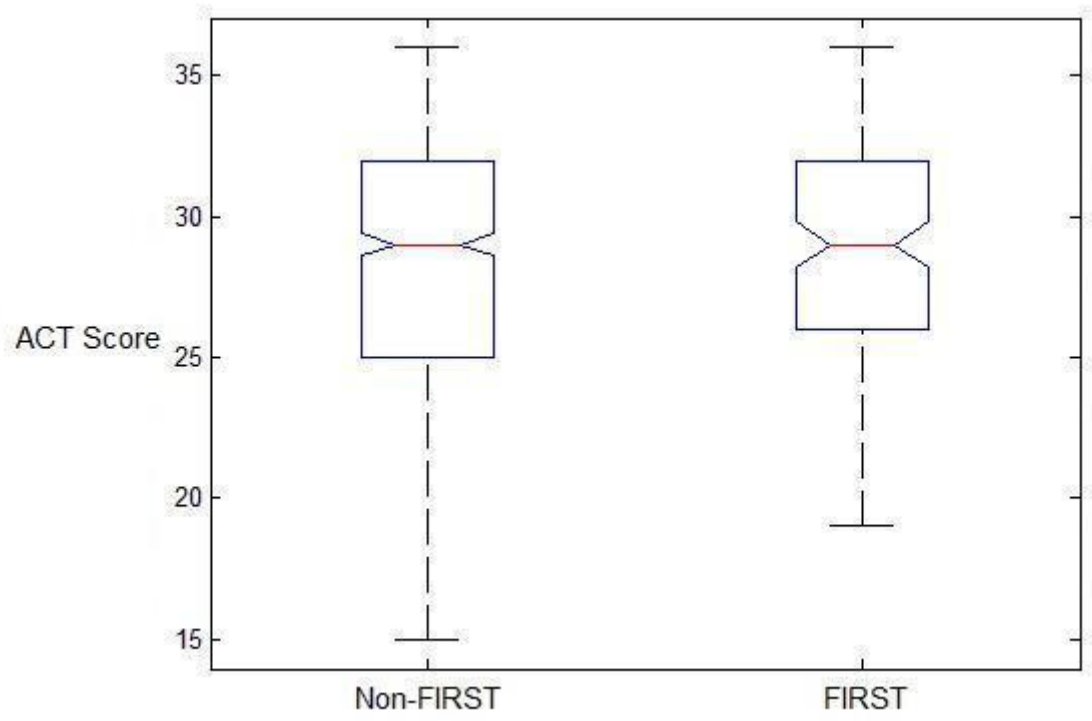

Figure 17 *ACT Verbal Scores for FIRST and non-FIRST*

Verbal	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	28.8759	3.9824	28.5901	4.2165	28.6345	4.1801
Class_of_2016	28.1143	4.1499	28.5152	4.1992	28.4624	4.1872
Class_of_2017	28.8759	3.9824	28.3589	4.1865	28.4482	4.1636
Class_of_2018	28.8759	3.9824	28.5901	4.2165	28.6345	4.1801

Source	SS	df	MS	F	Prob>F
Groups	8.5	1	8.4747	0.49	0.4862
Error	15315.9	877	17.4639		
Total	15324.4	878			

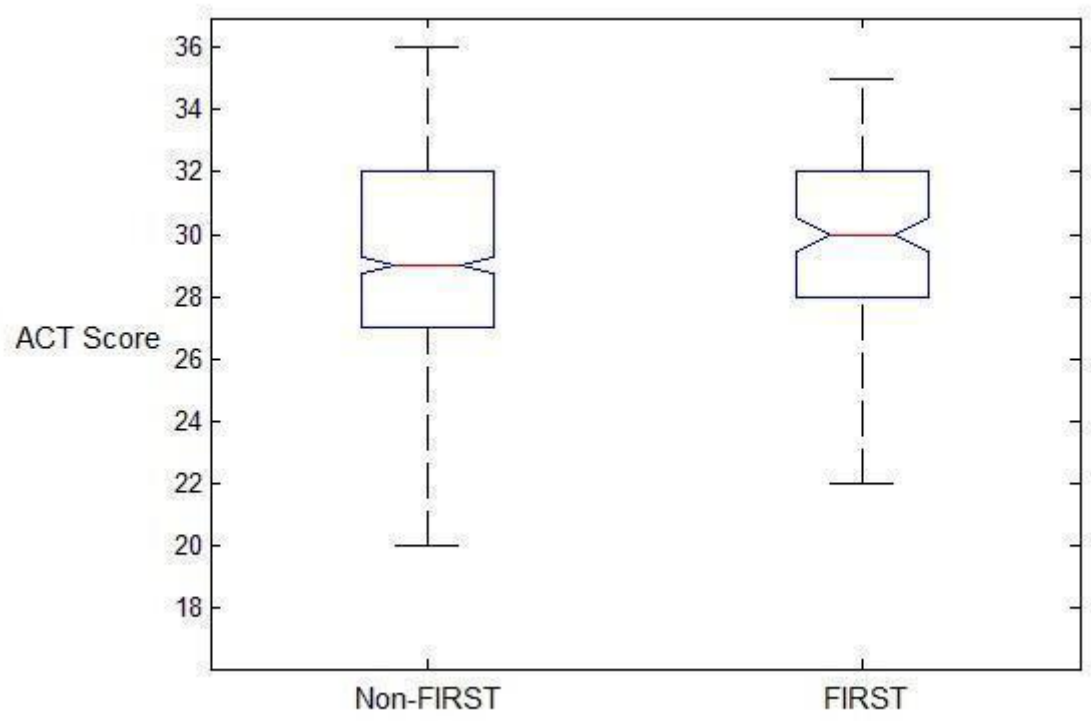

Figure 18 *ACT Composite Scores for FIRST and non-FIRST*

Composite	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	29.755	3.1825	29.186	3.2526	29.271	3.2469
Class_of_2016	28.676	3.6897	28.911	3.2211	28.882	3.2775
Class_of_2017	29.755	3.1825	29.124	3.211	29.255	3.1923
Class_of_2018	29.755	3.1825	29.186	3.2526	29.271	3.2469

Source	SS	df	MS	F	Prob>F
Groups	38.35	1	38.3513	3.65	0.0564
Error	9755.36	928	10.5122		
Total	9793.72	929			

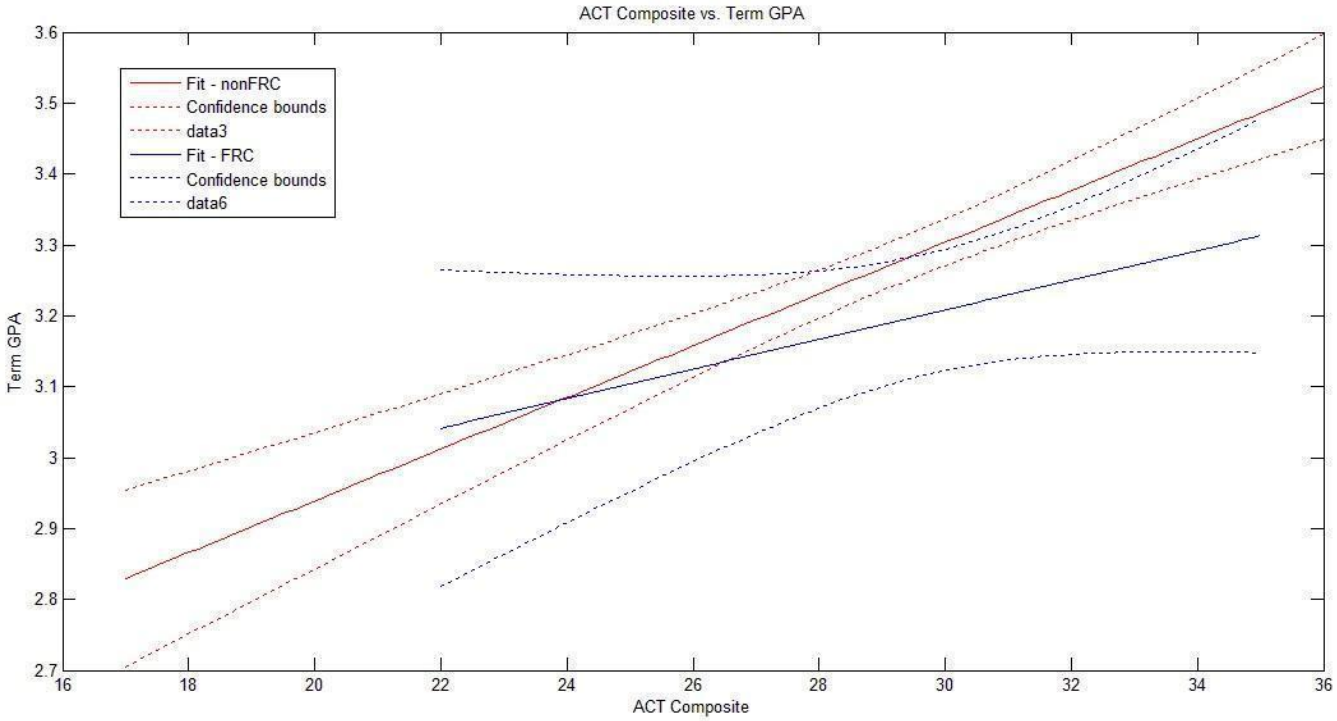

Figure 19 *ACT Composite Scores vs. College GPA for FIRST and non-FIRST*

```
FRC:
Estimated Coefficients:
                    Estimate      SE           tStat         pValue
                    ________      ________     _______       __________

       (Intercept)  2.5824        0.4042       6.3889        2.3839e-09
       x1           0.020866      0.013522     1.543         0.12511

Number of observations: 140, Error degrees of freedom: 138
Root Mean Squared Error: 0.51
R-squared: 0.017,  Adjusted R-Squared 0.00984
F-statistic vs. constant model: 2.38, p-value = 0.125


nonFRC:
Estimated Coefficients:
                    Estimate      SE           tStat         pValue
                    ________      _________    _______       __________

       (Intercept)  2.2095        0.14766      14.964        1.0212e-44
       x1           0.036472      0.0050253    7.2576        9.4889e-13

Number of observations: 786, Error degrees of freedom: 784
Root Mean Squared Error: 0.455
R-squared: 0.063,  Adjusted R-Squared 0.0618
F-statistic vs. constant model: 52.7, p-value = 9.49e-13
```

High School GPA

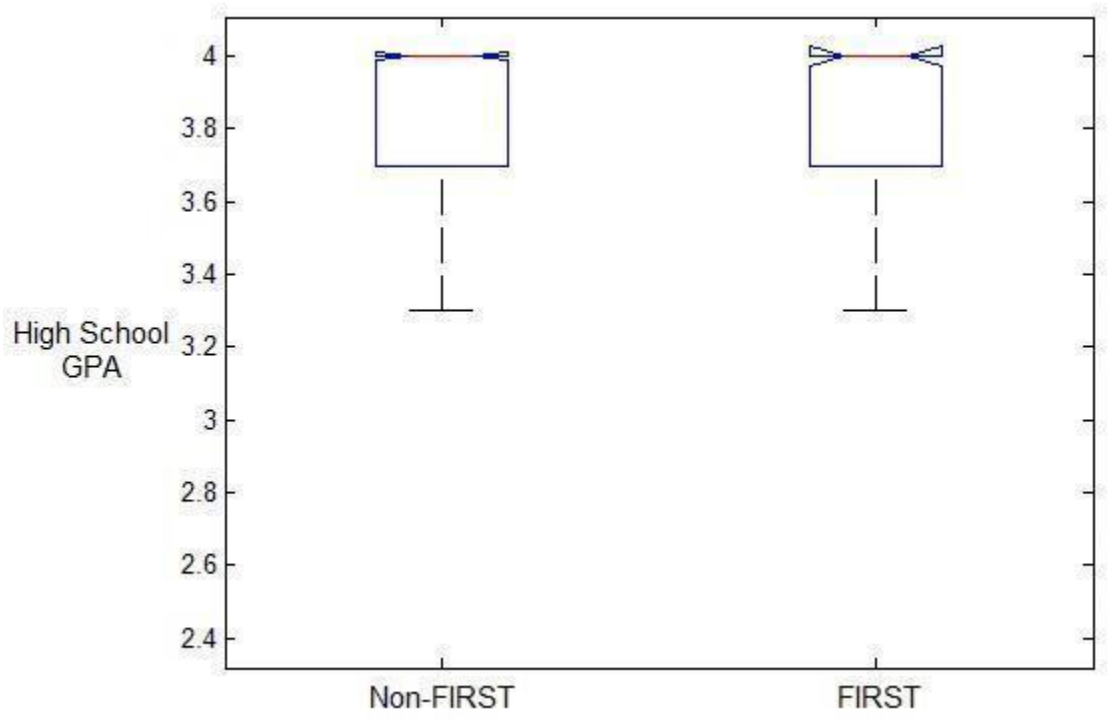

Figure 20 *High School GPA for FIRST and non-FIRST*

HS GPA	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	3.8272	0.26515	3.8359	0.29859	3.8349	0.29471
Class_of_2016	3.7833	0.28374	3.8248	0.26274	3.8202	0.26524
Class_of_2017	3.8272	0.26515	3.8523	0.35245	3.8515	0.34037
Class_of_2018	3.8272	0.26515	3.8359	0.29859	3.8349	0.29471

Source	SS	df	MS	F	Prob>F
Groups	0.021	1	0.02103	0.24	0.6228
Error	226.404	2606	0.08688		
Total	226.425	2607			

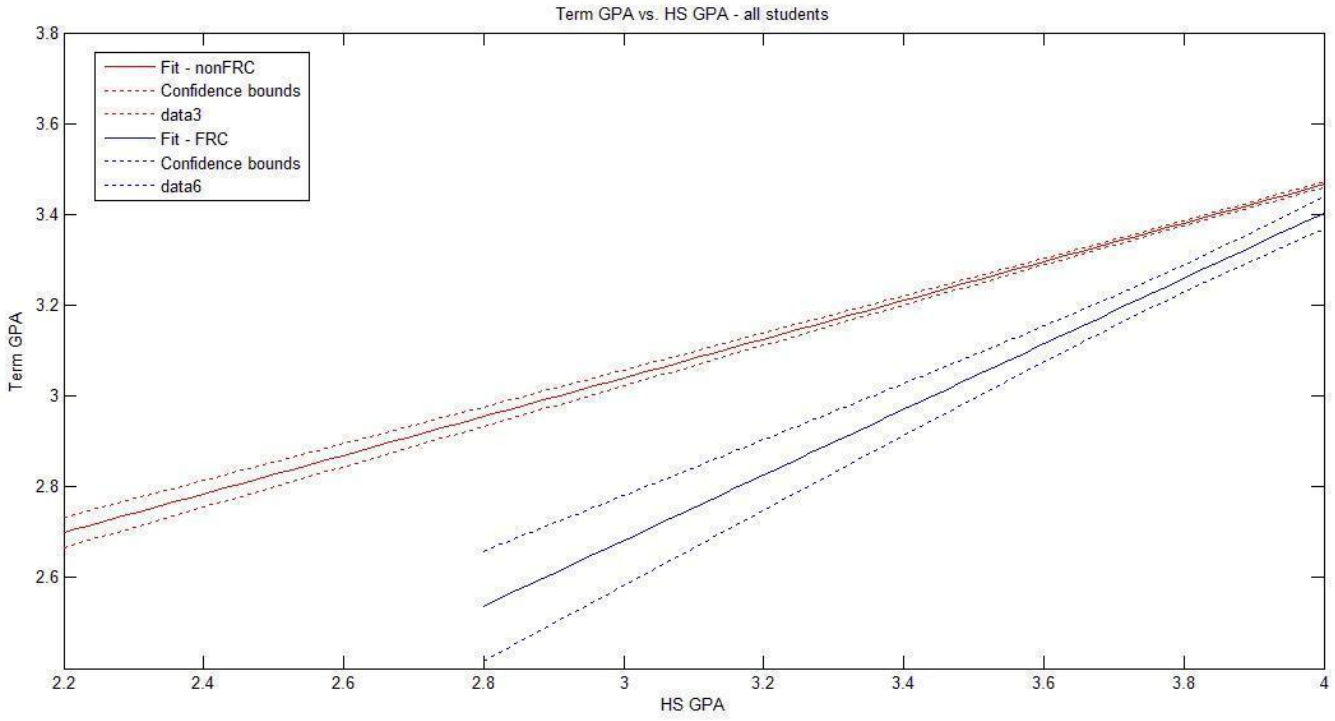

Figure 21 *High School GPA vs. College GPA for all years*

```
nonFRC:
Estimated Coefficients:
                    Estimate      SE           tStat        pValue
                    ________      ________     _______      _______

       (Intercept)  1.7617        0.039976     44.069       0
       x1           0.42605       0.010467     40.702       0

Number of observations: 26295, Error degrees of freedom: 26293
Root Mean Squared Error: 0.46
R-squared: 0.0593,  Adjusted R-Squared 0.0592
F-statistic vs. constant model: 1.66e+03, p-value = 0


FRC:
Estimated Coefficients:
                    Estimate      SE           tStat        pValue
                    ________      ________     _______      __________

       (Intercept)  0.51743       0.2234       2.3162       0.020742
       x1           0.7214        0.058255     12.384       5.7029e-33


Number of observations: 1051, Error degrees of freedom: 1049
Root Mean Squared Error: 0.498
R-squared: 0.128,  Adjusted R-Squared 0.127
F-statistic vs. constant model: 153, p-value = 5.7e-33
```

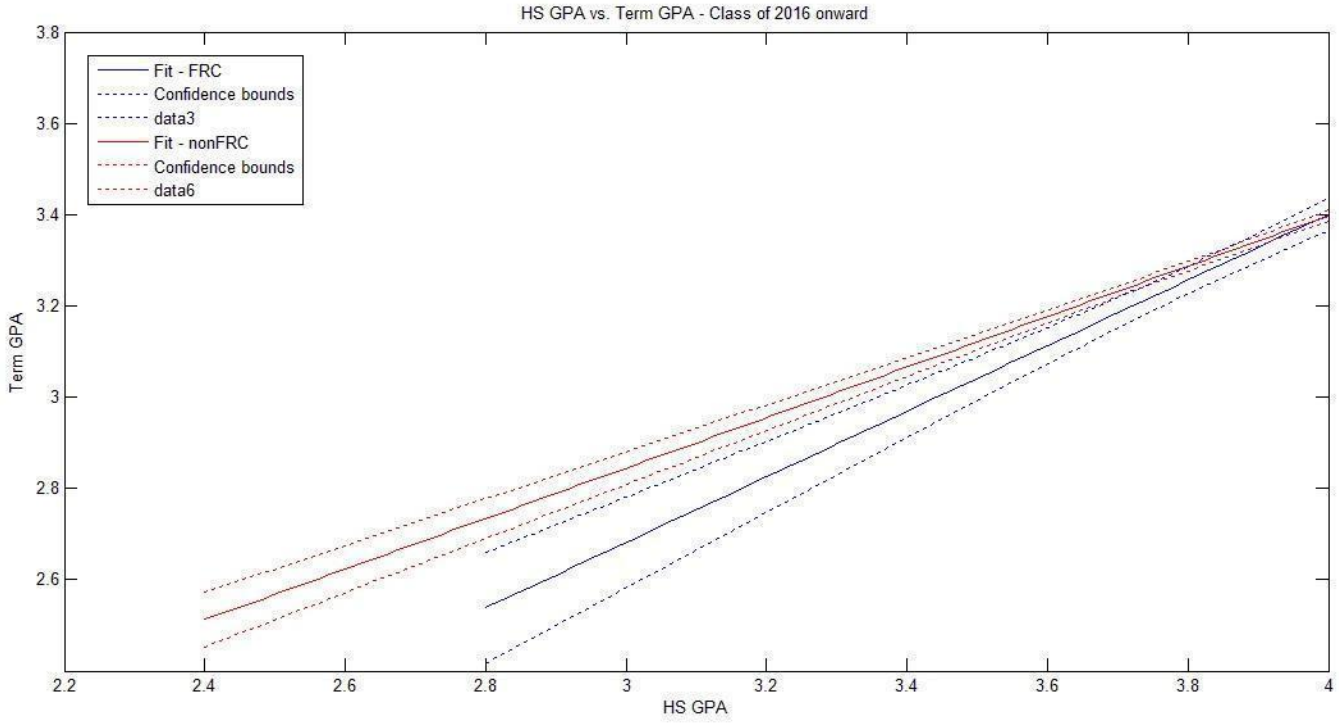

Figure 22 *High School GPA vs. College GPA for Class of 2016 onward*

```
nonFRC:
Estimated Coefficients:
                    Estimate      SE           tStat        pValue
                    ________      ________     ______       ___________

       (Intercept)  1.185         0.080087     14.797       6.8159e-49
       x1           0.55317       0.020817     26.573       3.6654e-149

Number of observations: 7993, Error degrees of freedom: 7991
Root Mean Squared Error: 0.476
R-squared: 0.0812,  Adjusted R-Squared 0.0811
F-statistic vs. constant model: 706, p-value = 3.67e-149


FRC:
Estimated Coefficients:
                    Estimate      SE           tStat        pValue
                    ________      ________     ______       __________

       (Intercept)  0.52629       0.22377      2.3519       0.018861
       x1           0.71843       0.058355     12.311       1.2744e-32

Number of observations: 1046, Error degrees of freedom: 1044
Root Mean Squared Error: 0.498
R-squared: 0.127,  Adjusted R-Squared 0.126
F-statistic vs. constant model: 152, p-value = 1.27e-32
```

WPI Credits

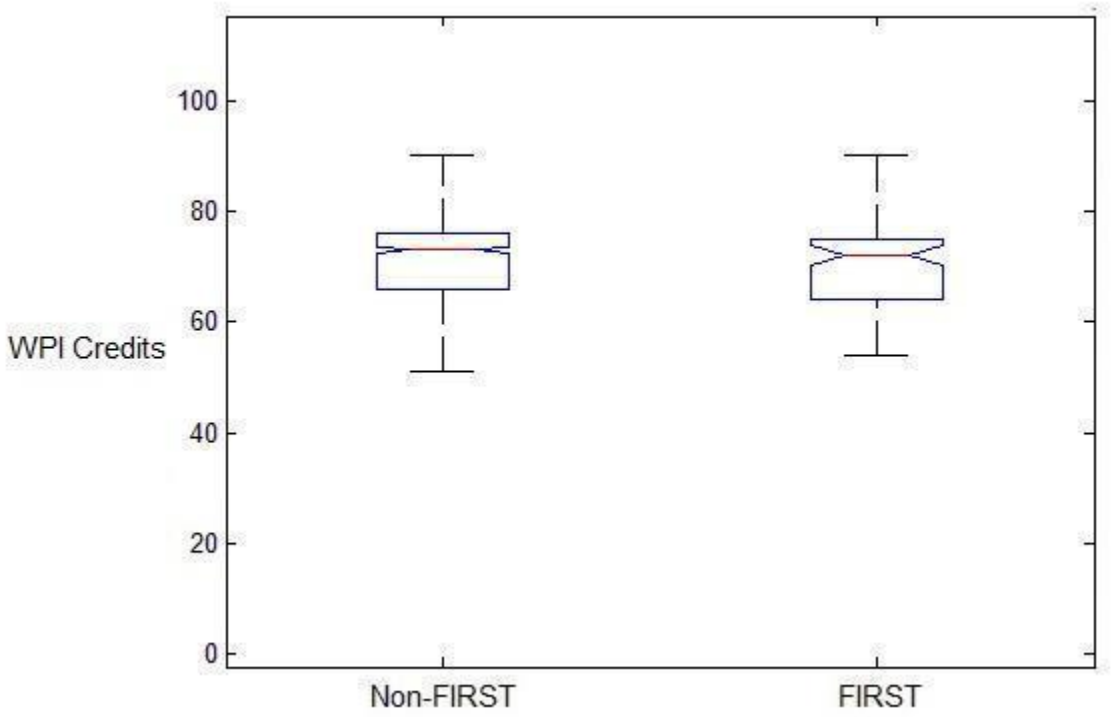

Figure 23 *Class of 2016 WPI Credits for FIRST and non-FIRST*

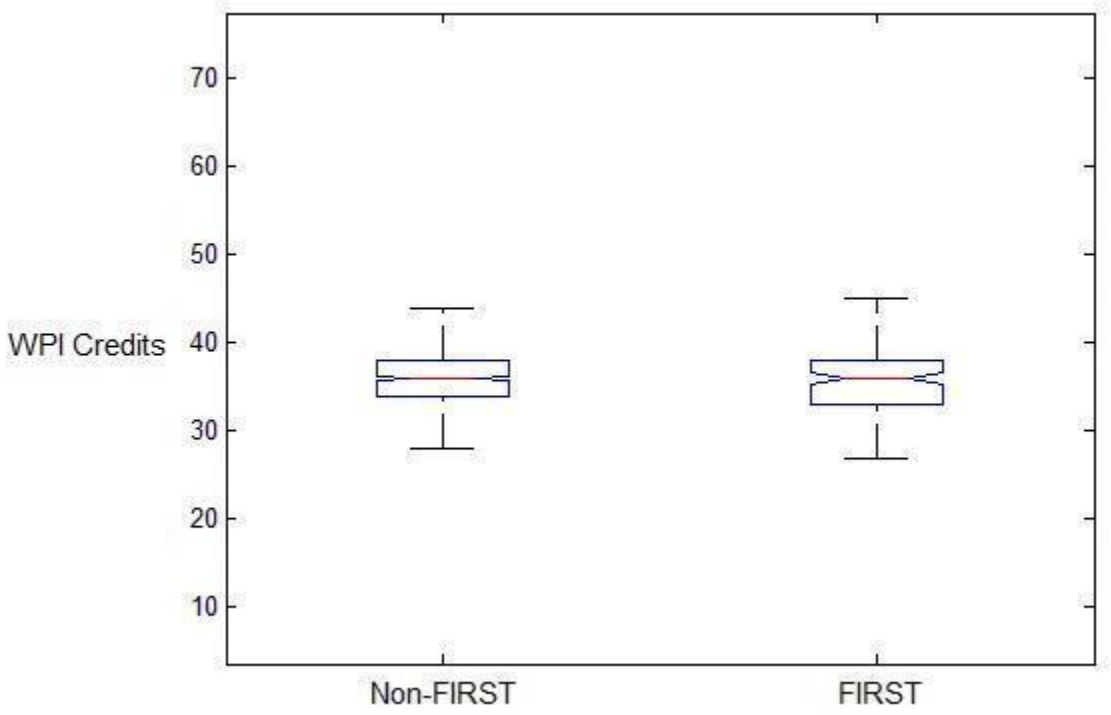

Figure 24 *Class of 2017 WPI Credits for FIRST and non-FIRST*

WPI	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	31.228	28.291	34.033	28.989	33.717	28.92
Class_of_2016	65.92	18.075	67.326	16.768	67.185	16.9
Class_of_2017	31.228	28.291	35.218	6.5982	35.185	6.6206

Class of 2016

Source	SS	df	MS	F	Prob>F
Groups	160	1	160.004	0.65	0.4214
Error	244395.1	988	247.363		
Total	244555.1	989			

Class of 2017

Source	SS	df	MS	F	Prob>F
Groups	33.2	1	33.2109	0.92	0.3379
Error	39417.2	1091	36.1294		
Total	39450.4	1092			

Dean's List

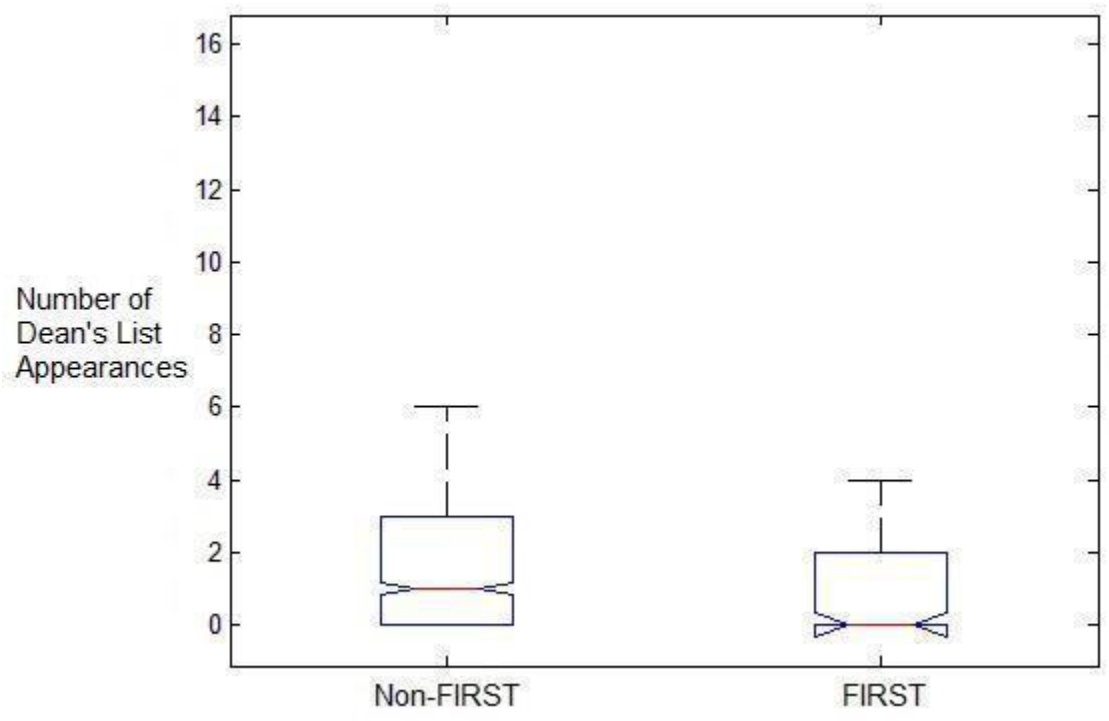

Figure 25 *Number of Appearances on the Dean's List for FIRST and non-FIRST*

	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	0.090141	0.28679	0.093638	0.29138	0.093245	0.29082
Class_of_2016	0.12	0.3266	0.13348	0.34028	0.13213	0.3388
Class_of_2017	0.090141	0.28679	0.14594	0.35323	0.14727	0.35454
Class_of_2018	0.090141	0.28679	0.093638	0.29138	0.093245	0.29082

Source	SS	df	MS	F	Prob>F
Groups	4.66	1	4.66253	1.89	0.1696
Error	7783.25	3151	2.47009		
Total	7787.91	3152			

GPS

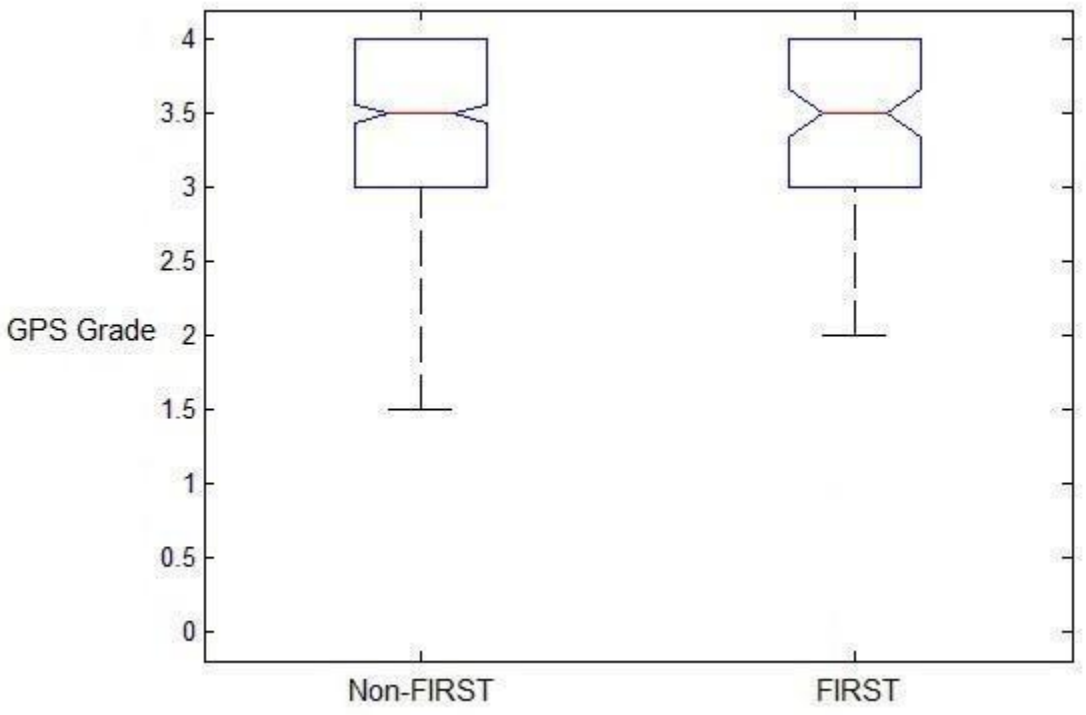

Figure 26 *GPS Grade for FIRST and non-FIRST*

GPS Grade	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	3.4396	0.79175	3.4836	0.68653	3.4783	0.69952
Class_of_2016	3.3333	1	3.5628	0.69343	3.5372	0.73492
Class_of_2017	3.4396	0.79175	3.4484	0.66832	3.456	0.65863
Class_of_2018	3.4396	0.79175	3.4836	0.68653	3.4783	0.69952

Source	SS	df	MS	F	Prob>F
Groups	0.061	1	0.06105	0.13	0.7163
Error	350.695	759	0.46205		
Total	350.756	760			

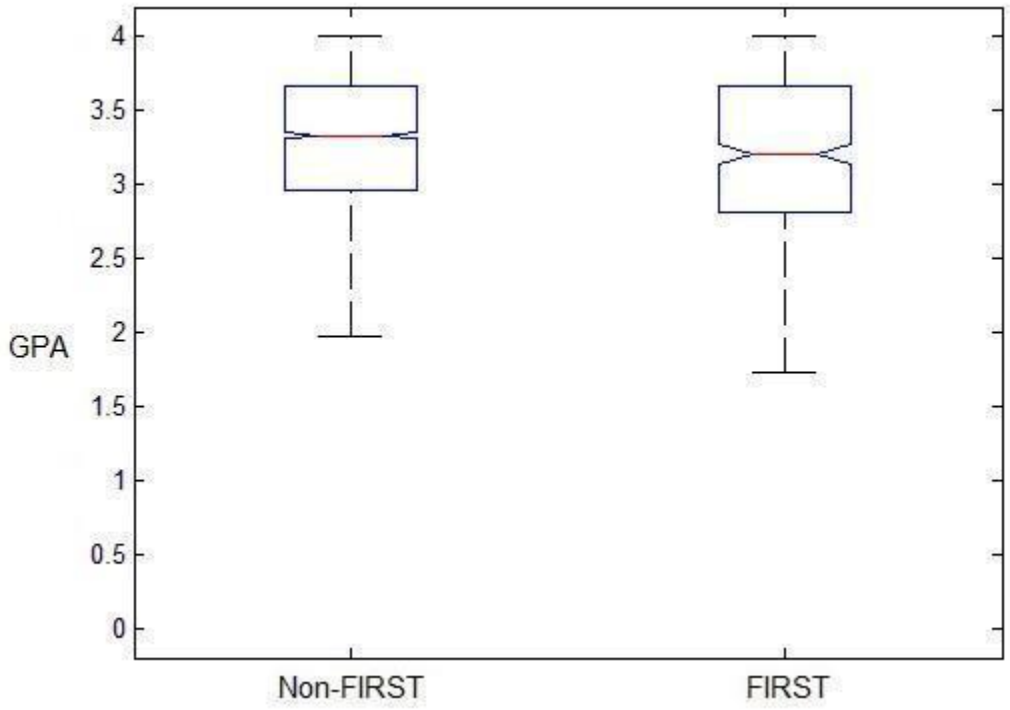

Figure 27 *Total GPA for all three Classes for FIRST and non-FIRST*

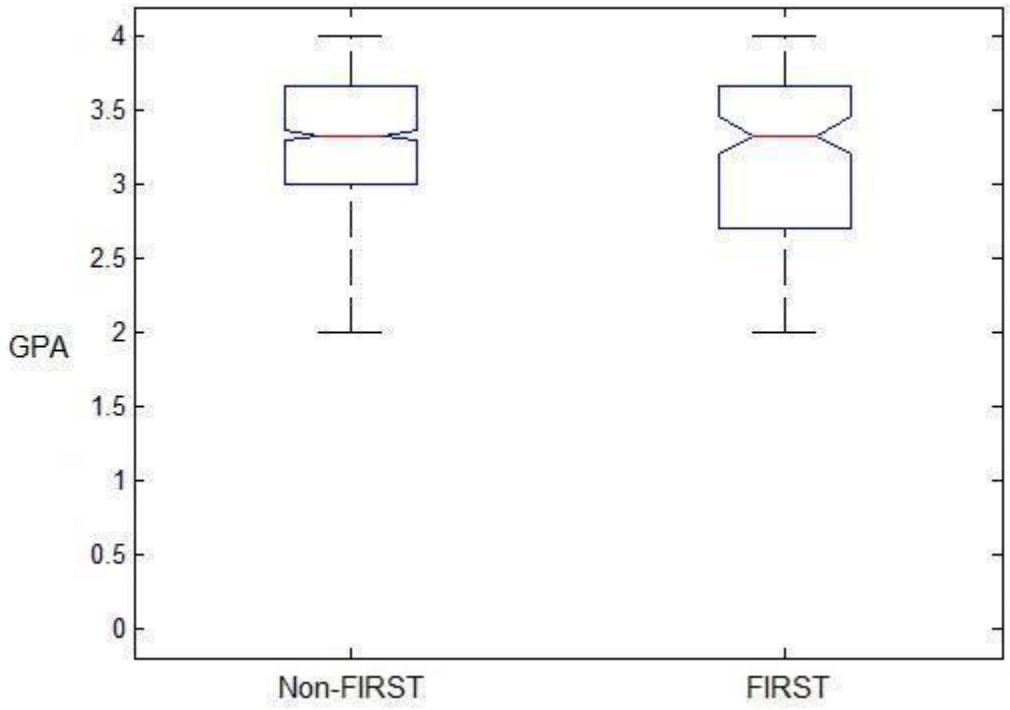

Figure 28 *Total GPA for Class of 2018 for FIRST and non-FIRST*

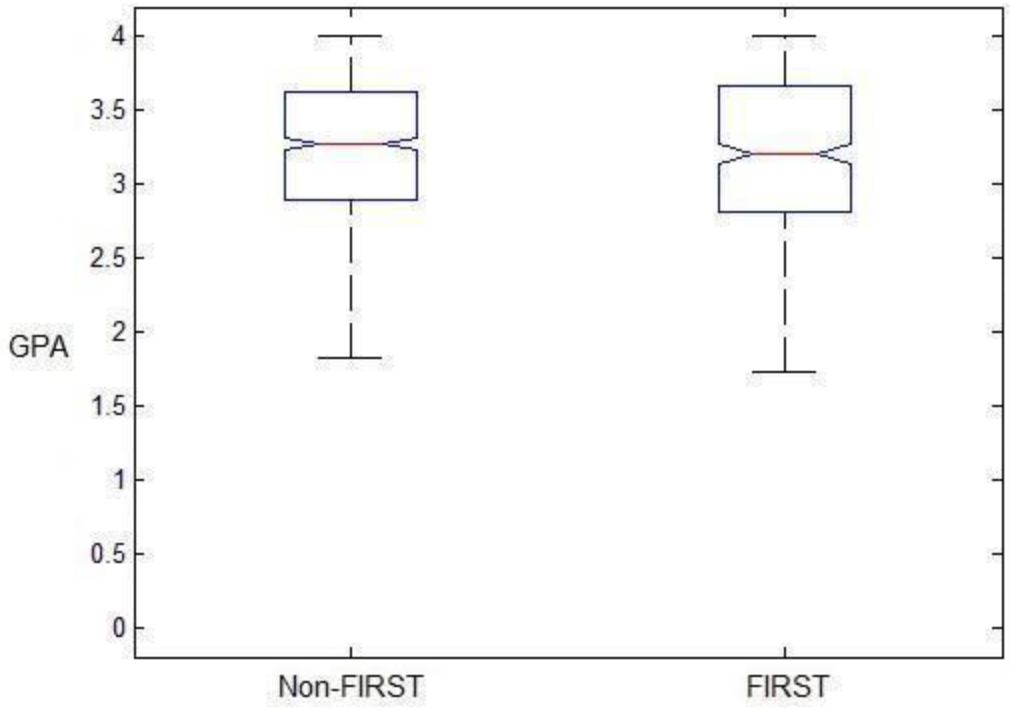

Figure 29 *Total GPA for Class of 2017 for FIRST and non-FIRST*

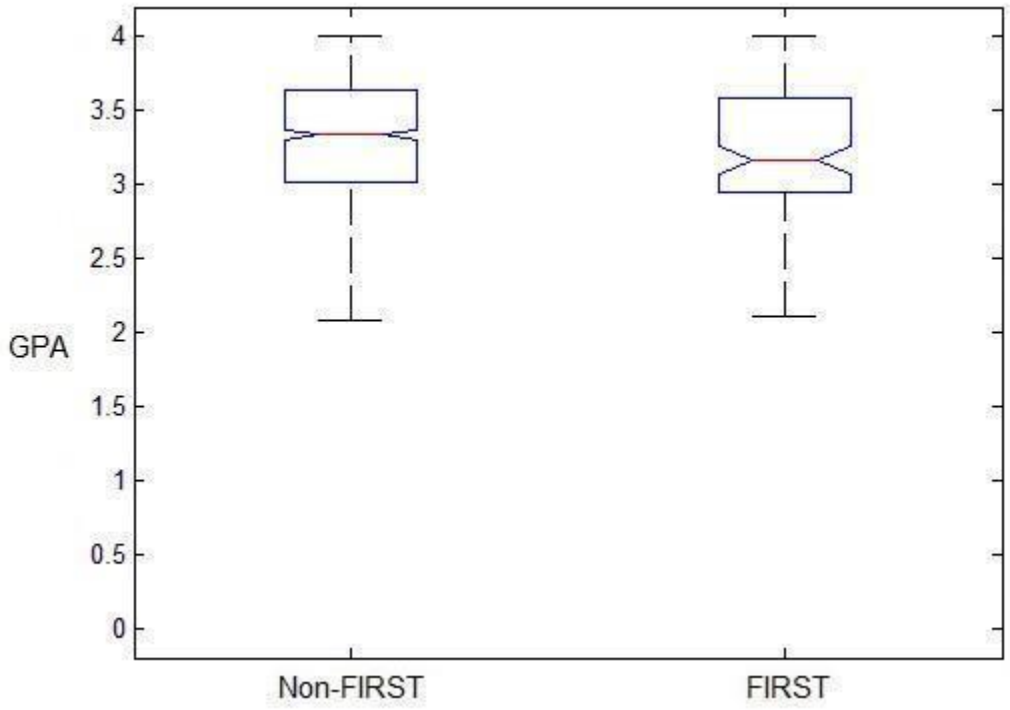

Figure 30 *Total GPA for Class of 2016 for FIRST and non-FIRST*

WPI GPA	FRC_mean	FRC_std_dev	nonFRC_mean	nonFRC_std_dev	all_mean	all_std_dev
All_Classes	2.9388	0.80236	3.0066	0.73043	2.9989	0.73905
Class_of_2016	2.7178	0.91427	2.8787	0.77174	2.8626	0.78813
Class_of_2017	2.9388	0.80236	2.9247	0.74788	2.9161	0.75296
Class_of_2018	2.9388	0.80236	3.0066	0.73043	2.9989	0.73905

All_Classes

Source	SS	df	MS	F	Prob>F
Groups	1.055	1	1.05521	3.58	0.0587
Error	930.016	3151	0.29515		
Total	931.071	3152			

Class_of_2016

Source	SS	df	MS	F	Prob>F
Groups	0.69	1	0.68987	2.95	0.0863
Error	233.371	997	0.23407		
Total	234.061	998			

Class_of_2017

Source	SS	df	MS	F	Prob>F
Groups	0.563	1	0.56339	2.04	0.1532
Error	365.758	1326	0.27584		
Total	366.321	1327			

Class_of_2018

Source	SS	df	MS	F	Prob>F
Groups	0.034	1	0.0343	0.09	0.765
Error	403.44	1052	0.3835		
Total	403.474	1053			

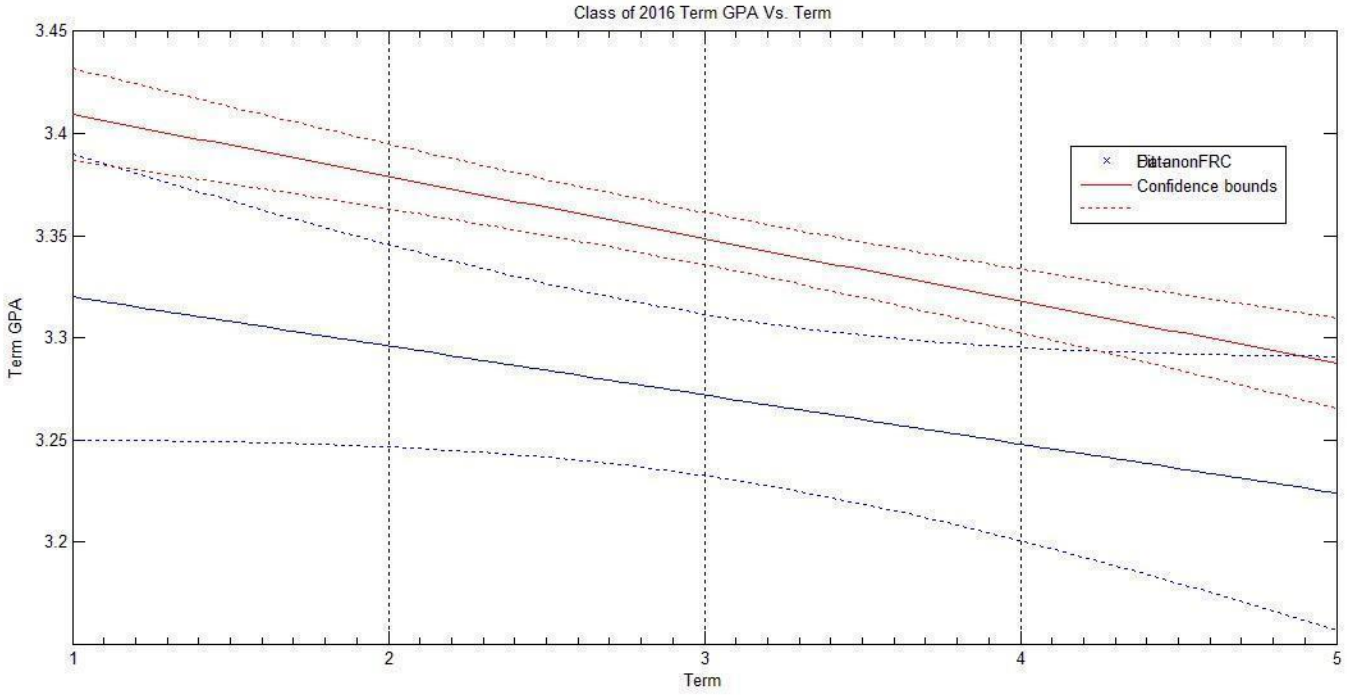

Figure 31 *GPA across semesters for Class of 2016 for FIRST and non-FIRST*

nonFRC:

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	3.44	0.015507	221.83	0
x1	-0.030515	0.0046398	-6.5769	5.261e-11

Number of observations: 5371, Error degrees of freedom: 5369
Root Mean Squared Error: 0.481
R-squared: 0.00799, Adjusted R-Squared 0.00781
F-statistic vs. constant model: 43.3, p-value = 5.26e-11

FRC:

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	3.344	0.048154	69.443	4.837e-296
x1	-0.024032	0.014247	-1.6868	0.092141

Number of observations: 627, Error degrees of freedom: 625
Root Mean Squared Error: 0.504
R-squared: 0.00453, Adjusted R-Squared 0.00294
F-statistic vs. constant model: 2.85, p-value = 0.0921

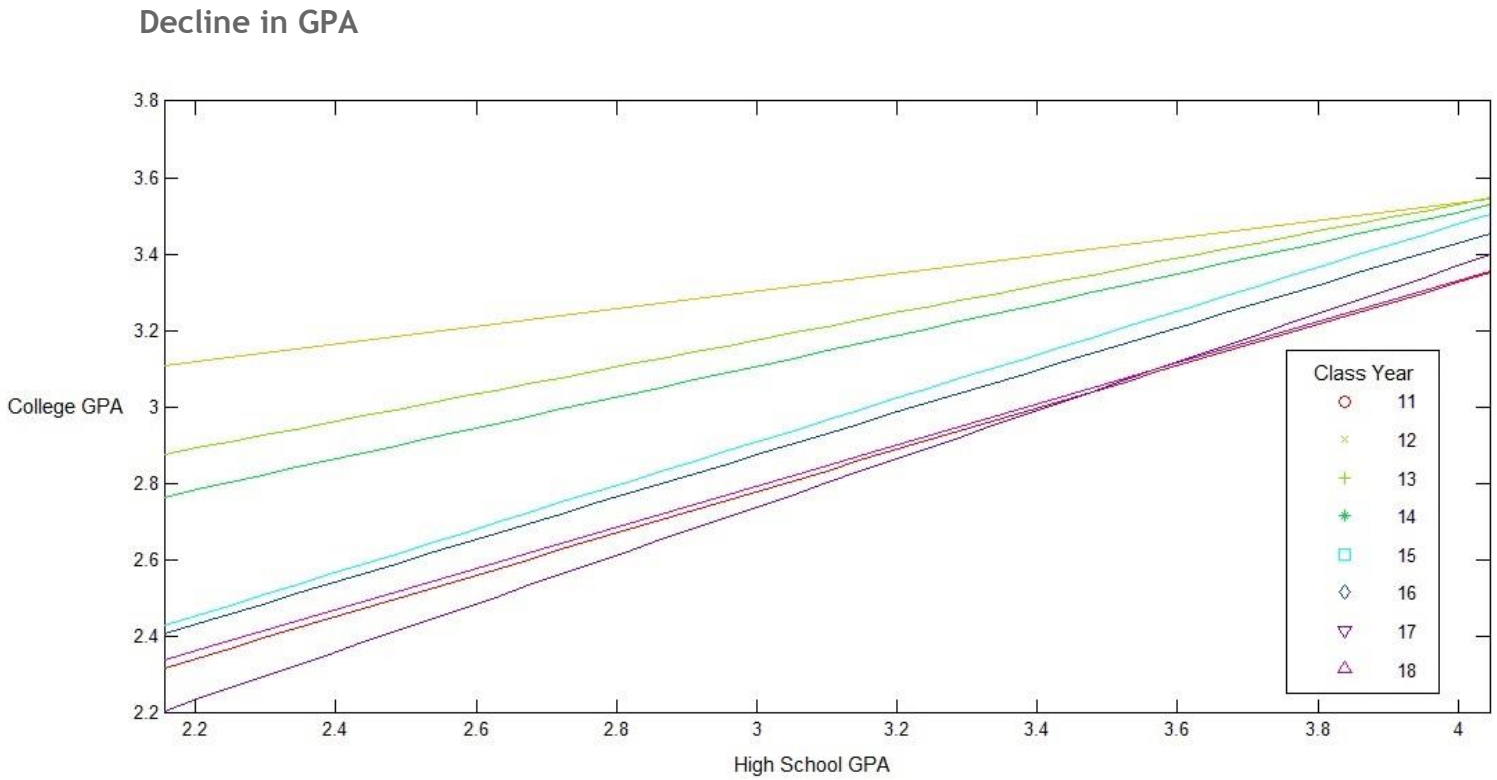

Figure 32 *Rainbow of Disappointment - College GPA vs High School GPA for all students for the past seven years*

Major

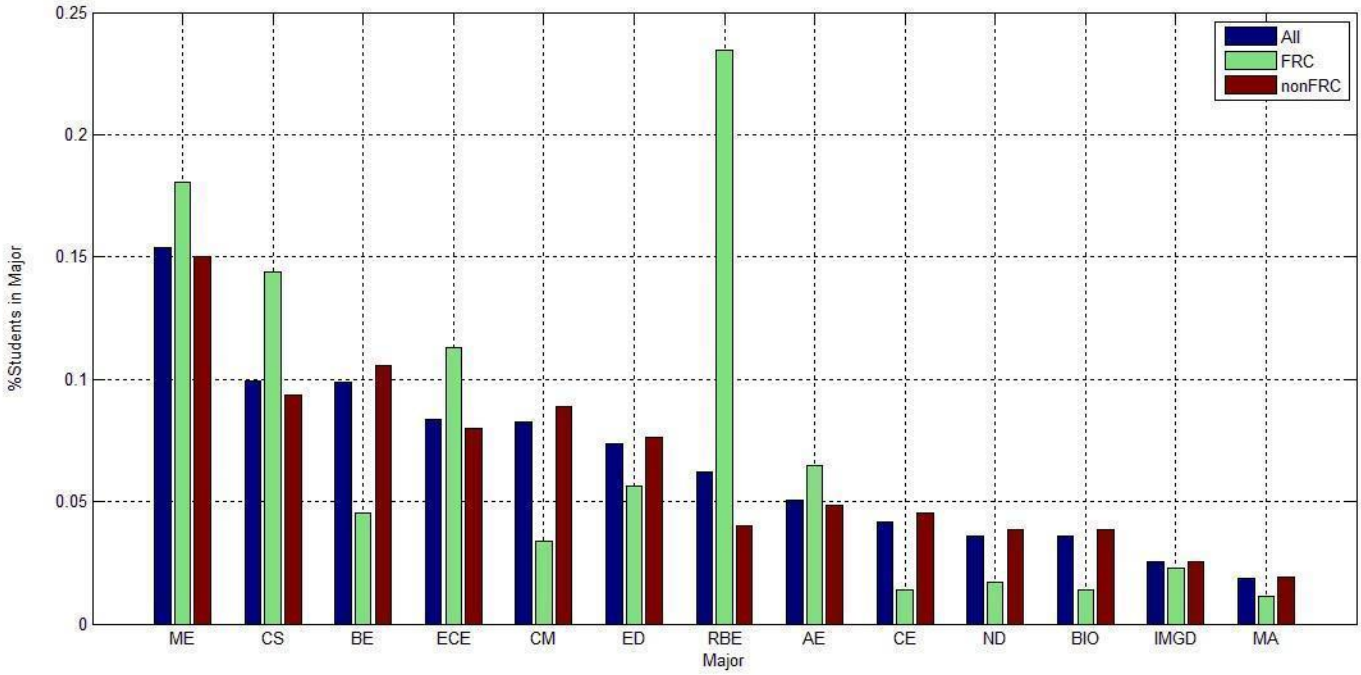

Figure 33 *Distribution of all students, FIRST students, and non-FIRST students across most popular majors*

	all	FRC	nonFRC
ME	483	64	419
CS	312	51	261
BE	310	16	294
ECE	263	40	223
CM	260	12	248
ED	232	20	212
RBE	195	83	112
AE	158	23	135
CE	131	5	126
ND	113	6	107
BIO	112	5	107
IMGD	79	8	71
MA	58	4	54

Table 5 *Number of students in majors*

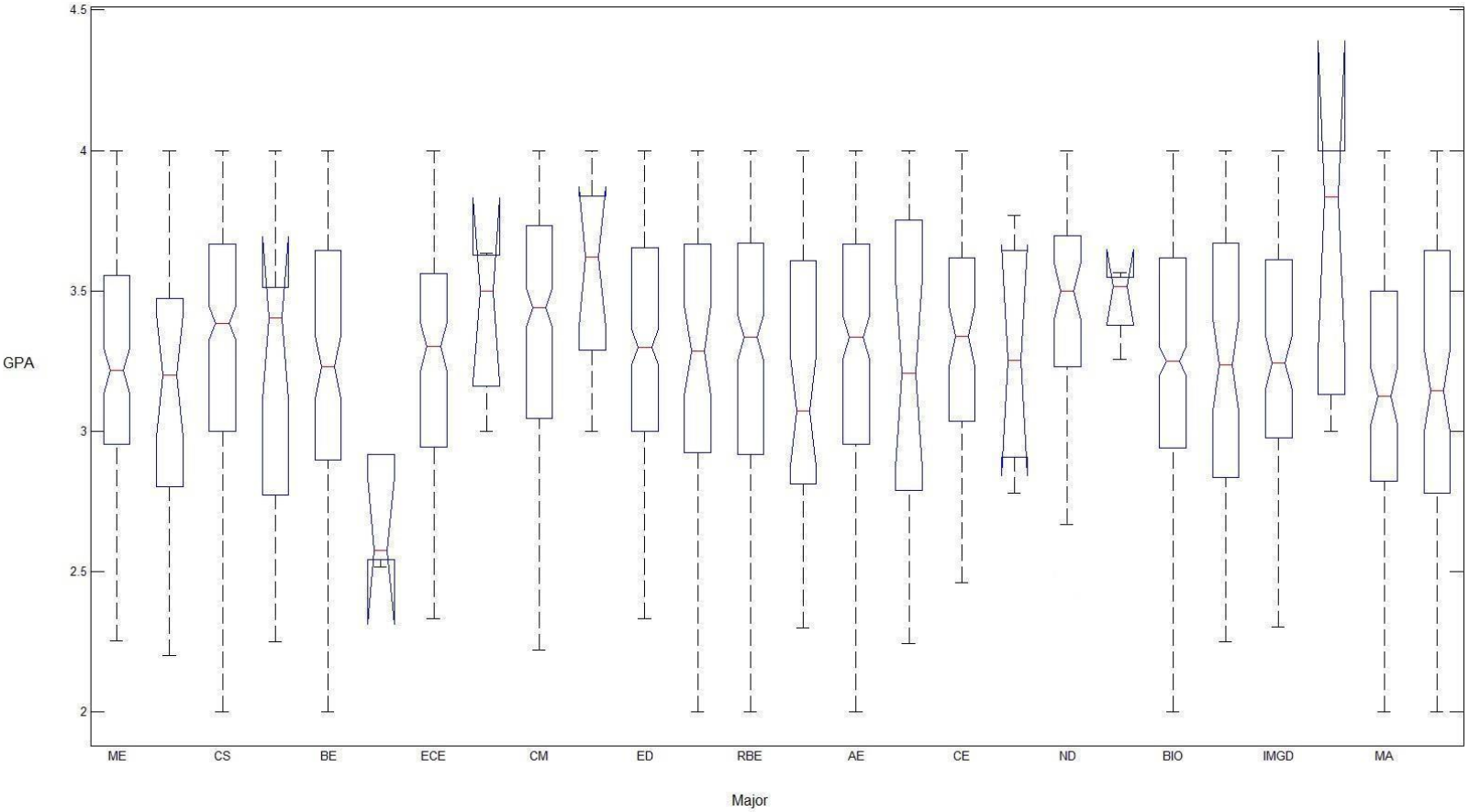

Figure 34 *Box plots of GPA for every popular major alternating non-FIRST and FIRST*

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	1.5278	0.11526	13.256	7.4558e-39
x1_1	-0.029022	0.027028	-1.0738	0.28302
x2	0.45621	0.029943	15.236	2.8682e-50

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	1.4996	0.1229	12.202	2.5137e-33
x1_1	0.0047791	0.028354	0.16855	0.86616
x2_2	-0.082401	0.08603	-0.95781	0.33825
x2_3	0.0033824	0.072756	0.04649	0.96292
x2_4	-0.15998	0.12188	-1.3126	0.18943
x2_5	0.085726	0.047724	1.7963	0.072567
x2_6	-0.035756	0.059448	-0.60147	0.54758
x2_7	0.19371	0.44902	0.43142	0.6662
x2_8	0.067912	0.05791	1.1727	0.24102
x2_9	0.23512	0.0993	2.3678	0.017968
x2_10	0.14242	0.049368	2.8849	0.0039479
x2_11	0.028392	0.048233	0.58866	0.55614
x2_12	0.20219	0.44904	0.45027	0.65255
x2_13	-0.012704	0.04972	-0.25552	0.79834

x2_14	-0.016794	0.44908	-0.037396	0.97017
x2_15	0.012664	0.050179	0.25237	0.80077
x2_16	0.019457	0.071365	0.27264	0.78515
x2_17	0.0042605	0.3187	0.013368	0.98934
x2_18	0.36168	0.31882	1.1344	0.25673
x2_19	0	0	NaN	NaN
x2_20	0.18278	0.086085	2.1232	0.033831
x2_21	0.10773	0.067401	1.5983	0.1101
x2_22	-0.022448	0.26123	-0.085932	0.93153
x2_23	0.46811	0.31882	1.4682	0.14216
x2_24	0.11973	0.079919	1.4981	0.13423
x2_25	0.20975	0.086031	2.438	0.014834
x2_26	0.018176	0.044505	0.40841	0.683
x2_27	0.05796	0.12205	0.47488	0.63491
x2_28	0.095243	0.14064	0.67719	0.49834
x2_29	0.03875	0.14715	0.26333	0.79231
x2_30	0.097585	0.060037	1.6254	0.1042
x2_31	-0.036531	0.083164	-0.43926	0.66051
x2_32	0.23268	0.17351	1.341	0.18003
x2_33	-0.22683	0.26119	-0.86844	0.38523
x2_34	-0.071907	0.054327	-1.3236	0.18576
x2_35	0.031129	0.13484	0.23086	0.81744
x2_36	-0.15284	0.44903	-0.34038	0.73359
x3	0.45231	0.030231	14.962	1.3922e-48

Appendix C: Transcript of Interview with Edward Connor, Dean of Admissions

Greg:
I guess the idea that we're trying to work with here is that we want to prove that FIRST students are more successful in a way than non-FIRST alumni, that they have more leadership positions, they're doing slightly better not necessarily by grades but just by how well they're doing on campus.

Connor:
Particularly what we need from the office of admissions is a record of approximately how well people did in high school. There was a study from Brandeis which shows a correlation between students with lower performance in high school being encouraged to apply and successfully get into colleges. So we want to correct our data for what we expect to be a lower average performance in high school for FIRST students. We were hoping to get data about participation in FIRST from the office and we've also been told that the office has an index they use to rate how fit an applicant is to join WPI or something along those lines.

Dean Connor:
I wouldn't say there's really a, when you say fit, are you thinking subjectively or more based on academic parameters? The latter is true to an extent. Let me take a step back. Identifying the students who participated in FIRST, we do our best to do that if students disclose that as part of their application or maybe we met them at an event and indicated on an inquiry form that they did that. So we do have pretty good data on who applied that was involved in FIRST coming out of high school. The one thing to keep in mind is that this could mean they were involved for two months their freshman year in High School or they've been the team captain for three years and we don't really distinguish that in terms of how we collect the data. Just something to keep in mind for your analysis as well, that the participation numbers for most of them I expect it's been a fairly substantial part of their career but it's probably going to be a little bit skewed by students that were involved for a short amount of time. So as we look at candidates we look at academics first and foremost and there's certainly parameters we look at but a lot of what we're also looking at is in comparison to the rest of the applicant pool and how strong that student is so there's not so much of a sort of indexing of what makes a good fit. In terms of an academic fit we are certainly looking for rigorous courses and I can give you information about the general academic profile that we're looking for and there's not really any cutoffs or any guarantees in terms of if you beat this GPA and test score you get admission, or if you fall into this range you won't be admitted, there is some subjectivity in what we're looking at as well.

Connor:
What we're mostly hoping for is boiling down all the different variables that go into determining how desirable a student is to apply which would include GPA and SAT/AB, and even if it's not a baseline zero and everything's measured off of that, even if it's relative to other students, that's still something that we'd look for to simplify our analysis.

Dean Connor:
First and foremost, anything we provide would be based on an ID system so that we wouldn't be sharing any personal information on a particular student. There's a lot of subjectivity that goes into the process so

I'm a little worried about conclusions that might be drawn from trying to boil this down to an index or numerical system. We do do some ratings to try to help balance out, like, the three of you probably went to different high schools, each high school probably calculated your GPA differently, they probably had different levels of courses, so we do do some rating to try and help compare and contrast these but there still is a fair amount of subjectivity that goes into the overall analysis of who would admitted or denied. Some student might interview, if it's a positive experience it could help the student through the process, one student might have written a lousy essay that could hurt him, it's not like all these factors have a numerical rating, we don't rate an essay, we discuss it, we don't rate the interview but we discuss it. I don't want to sound like I don't want to help, I want to try and make sure that for your and our sake that what you're looking to do is an accurate representation. You're hoping to show that students that are participating in FIRST overall might have a lower academic performance than other students coming out of high school would wind up performing at or above other students while they are here.

Connor:
Yeah, that's what we're looking for. Would it be possible to talk to whoever develops the methods you use to rate the students to try and find one that uses interview less and focuses on interviews less and more on academic performance?

Dean Connor:
Well that's me, and it's all one cycle. While we might do some ratings to help us balance out differences in high school and things like that, even a rating score does not guarantee someone admission or guarantee that they will be denied admission. Probably close to half the students, that admission committee you may hear about, we're sitting around discussing whether or not we're gonna admit this student. This is the piece where you're trying to do more of a statistical analysis is kind of lost, and I'm not trying to pretend that we have a crystal ball, it's not like an art, but there's a lot of factors and sometimes we have certain information that others don't have like an interview, FIRST students are notorious for submitting extra information about their build season and things like that and we take that into consideration. Giving you a profile of the students that were admitted and were involved in FIRST is something that we could probably do. Have you talked to anyone about access to the other side of this?

Connor:
We have to specifically avoid looking at GPA, we haven't had an appointment yet with the registrar to see what they think because we want to try and develop something more rigorous especially with the performance in high school, something that would be independent of participation in FIRST. So things like interview and information from FIRST could skew our data. So if we could focus entirely on Standardized tests and GPA in high school, that will give us the most independent data that we can get.

Dean Connor:
Standardized testing is pretty straight forward, and even though we're test optional, the majority of students still submit standardized tests, maybe 90% do submit testing. GPA we do not recalculate, so we do capture something but it could be heavily weighted if a student is taking more advanced courses, in other cases it might be deceivingly low if a student is in a school that doesn't weight the GPA, but they were in a lot of rigorous classes. Those are some of the things that the discussion component that gets kinda lost as far as looking at the numbers go, but if we have a GPA it's certainly something that we can

provide, but I can show you a student with a 4.0 but Cs on his transcript, I can show you a student that has a 3.2 and has all A's and B's and 12 AP courses and a patent, it just kinda skews things as well. But if you focus on those two pieces and the piece of whether or not they were involved in FIRST, let me have a few conversations with folks just to make sure, from my point of view that this can be released and provide some sort of an ID and that you can correlate this with something that you would get from the registrar's office. And make sure that the powers that be are comfortable in releasing the type of information we were talking about. I think that if it's pretty much blind information there won't be an issue. Who's your advisor?

Connor:
Stafford.

Dean Connor:
OK, let me talk to a couple folks over the next few days and see if, I would say that are you looking for one year or over the course of a few years?

Connor:
We're looking to get as much data as we can, if we can get data from years that have students who have graduated that would be very helpful, but I know that you've just recently started keeping track of that.

Dean Connor:
Yeah, I'd have to see how far back that goes, We went to the new system 3 years ago for application review and we started tracking a lot more things, I'm not a hundred percent sure if we were tracking FIRST for that first year. I know the last two years we were for sure but that would only give you freshman and sophomores, but I can find out and see if we have a third year. And like I said if we can provide some stuff I'll try to write out some of my concerns like the weighting of the GPAs and things like that, and the fact that you're not necessarily looking at the course rigor and things like that just to make sure that you keep things like that in mind when you're trying to draw conclusions. I think you're right, there's not much besides the GPA and SAT that doesn't have a certain amount of subjectivity and even then the GPA really does because their calculated in different ways, anything I would give you would be on a 4.0 scale, the only thing we do is convert, if we get something on the 100 point scale we will convert that. There are schools that don't provide any GPA, there are schools that use a 7 point scale, that use a 113 point scale, that use a written narrative, that use all kinds of different things. You'll probably see GPAs from 75% of the applicants. One other thing that we could provide, if we can provide information, is we could provide class rank if that's useful at all, in terms of a percentile. I'm not sure if that's helpful, it's probably littered with more landmines than some of the other things we've talked about so far, just because of rigor and weighting of courses and things like that. I can always throw that in if you're interested.

Connor:
So if we wanted to get some help developing a more rigorous way to analyze this because you seem to have a system that deals with a lot of other factors, would we continue talking to office of admissions about that or is there someone in particular you know could help us?

Dean Connor:
We could certainly talk some more, I think it's more of a subjective process than most people think, there are a couple folks on campus that do data analysis and things like that. I don't know what Professor Stafford's background is, I know it's in robotics, but you'd want to talk to someone in the mathematics department, someone with more of a statistical background, an actuarial mathematics kind of person, that might have some more insights. I could certainly talk to you a bit more but in terms of a more formulaic indexing approach I may not be the best person to talk to about that because it's not really what we do.

Monika:
So our goals, we have several metrics that we're using to measure their success in college, none of that includes GPA, things like awards, officer positions on campus, honor society memberships, do you think that analyze that we'd go to a statistics professor or would we try to speak to you?

Dean Connor:
When you say analyze that I'm not quite sure I follow.

Connor:
We're trying to boil down both performance in high school and performance in college each into their own single number to simplify analysis

Dean Connor:
(Good luck)

Connor:
Is there anyone in particular on campus that we should go to?

Dean Connor:
Well Melissa Lahey works in the enrolment area and she does some analysis but not that sort of analysis, she might look at a student's performance and retention rates, but larger, not boiling a student down to a number, she looks more at the students and how they are performing from one year to the next. Like the group who came in 5 years ago with a lower SAT performance, how are they performing as a group of a thousand students as supposed to this year's group who came in with a stronger average, so I'm not sure she's the right person. I'm not sure to be honest, you could check with Stafford or you could set up a conversation with the head of the math department just to see if they have some thoughts if there's someone on campus who can provide a little help. There's somebody and I can't think of the professor's name that met with me last year, and the project was not an MQP or IQP, it was an independent study that never got off the ground, and they were doing some analysis of student performance and were looking at Toffel Scores for International Students who tested with English as a foreign language in terms of how that impacted performance. Once students got here looking at more than the first year, sometimes we hear students struggling a little bit the first year but ultimately not over their four years. There was a professor who I think was social science and I can't think of his name, his office is in Salisbury, and maybe Professor Stafford would know, and maybe Jim Deasey would know, he's the head of social sciences here. My sense was that he had some background in that area and that he was using computer models as well, so that might be helpful. So let me talk to a couple folks to make sure that overall as a university that

policies go that, normally people ask for information and I can't provide it because it's personal information, but you're looking for this obviously blind, I think this is something we can provide, but I just need to check with a few of the lawyer-y types on campus to make sure everybody is comfortable with that.

Connor:
One last thing, if we were to do that we would need to be getting data from multiple sources, one of which would be surveying the student body. Would there be a way to just hand you or whoever would be controlling the ID system information about certain students and getting a new set of information that was more confidential?

Dean Connor:
So you're saying how would you get the surveys to the students without knowing who they are, that could be possible to do. Not impossible but it could be time consuming for somebody to do and without sharing identities. One way to do this would be to provide you a list of students that were involved in FIRST in high school, if you were then looking to interview some of those students, you very well could ask students to disclose their performance in high school. You might get as much information if not even a little more telling information if you ask students what their GPA was, what their test scores were, what their course rigor was. That's the other way to look at things that might ultimately solve the issue of how to get the surveys around. So that's something if you want to think about that way of looking at things. I can certainly still talk to the powers that be about providing the information you initially asked for, but I don't have a good way of linking up the surveys.

Connor:
Would there be any chance of us being able to sign confidentiality agreements and just dealing with the names and assigning IDs that don't have any kind of identifying information when we do give this report?

Dean Connor:
Let me talk to some folks about that, that's beyond my pay grade as they say. If you talk to Heather Jackson over at the Registrar's office, she's much more in tune with a lot of the guidelines because most of the guidelines really protect students once they're a student here. If you were asking for information on applicants I could provide that but being that they are students here that's sort of under a different umbrella, and we probably could do something so let me talk to her a little bit and it sounds like you guys will be meeting with her as well to find out about that. I think I have a good handle on what you're looking for, let me see what we can provide, maybe worst case scenario it's a matter of providing the identities of students involved in FIRST and interviewing them and asking them to self-report academics.

Connor:
And if we talk to some statisticians, there's a chance we don't even need identities, we just need to find trends, so there is that possibility.

Dean Connor:
The other thing, if you were to survey students and kid of go that route, one other possibility might be instead of asking about a GPA, I know you're trying to index this and boil down, so sort of on a 1 to 5 or

1 to 10 scale to rate your academic performance, kinda that sort of thing might allow you to boil it down more easily but I'm not a statistician. So give me a few days, we have an open house on Monday, so Monday is kind of offline, I usually meet with one of the Vice Presidents on Thursday, who since she's my Boss I'd ultimately want to have sign off on this, but in the meantime I can also just kind of talk to other people about this and get a general sense about what they think. Give me about a week or so, I know you guys are certainly in a hurry, but in the meantime if you talk to the registrar, it's like that we'll be ultimately in sync either being able to provide things from both or neither. So I'd encourage you not to just wait for me because it'll take me a few days before I can get back to you.

END

Appendix D: Transcript of Interview with Heather Jackson, WPI Registrar

Monika:
We were wondering if you had any input on what constitutes success at WPI.

Ms. Jackson:
Yes. It depends on what you're looking for, I can't give you student names or anything. I can give you aggregate information, so if you were to ask me for example…
And I can get, depending on what you're looking for, (for example this is an internal document) (so to give you an idea since you're asking about success). I'm in charge of graduation, obviously, so I have all kinds of, I just sent a list out, actually, to the consortium people, they were asking me about graduation numbers. So this might not be what you're looking for but this is just an example of what I can do, so I can say alright, we graduate 3 times a year, you probably know that, and it goes October, February, May. So for last year we had 1575 who graduated and it's broken up by, we do have some MBAs, you might not know that, mainly BS and PHDs and BAs and etc. So that's aggregate information, and then what I also do, I did a breakdown by major, and then what I think you're looking for, is more along the lines of this. So we have, basically, students can go from good academic standing to academic warning to academic probation and then suspension. So this is aggregate information right here and this tells you, you might be looking at, so, for the fall of 2013 the freshman who came in 39 were placed on warning. So I can give you stuff like that, but when you talk about, are you looking for a certain cohort of students? That's where I got confused.

Connor:
What we're studying is the performance of certain students who have participated in FIRST Robotics over time.

Ms. Jackson:
Yeah, so how do I know who they are?

Connor:
Admissions knows who they are, so we talked to the Dean of Admissions on Monday, and he said he could get us quite a set of data, and it would be on individual students but it wouldn't necessarily be by name. And that he was actually going to talk to your office about figuring out what data can be shared without actually giving us the names of individual students, just encoding it so that everyone has a number that's not related to their IDs or anything. So it's completely anonymous but we still have individuals because we want to look at a lot of different strata over a lot of different variables, so we need individual students, but we need to somehow still have it anonymous so we can actually use it without any kind of legal issues.

Ms. Jackson:
And what we could do is, when I download things for example, I want student ID number, first name, last name, sometimes we call it PID, from banner, so what we could do is download everything and then strip that. But then if you have a question about like line 5, we might be like 'we don't know because we stripped everything out'. So I think that's definitely doable, and if you've already talked to Ed, so the way

that the divisions are set up, enrolment management consists of admissions, grad admissions, registrar and financial aid. We have an information analyst (she is actually right down the hall, you might have passed her), she is the one who would probably gather all the data. So she'll probably talk to me and talk to Ed and then we can say, ok, get all this information, we'll look at it, strip out all the information that we shouldn't be giving you and give you what you do want.

Connor:
OK, so the kind of things we'd be looking for were not just graduation rates, but when people are dropping out, which would be the suspension part?

Ms. Jackson:
Well it depends. Some students opt to leave WPI on their own, like person situations, and then some are told they have to leave or suspended academically, and there are judicial suspensions as well.

Connor:
That distinction would probably be useful to us. We were hoping to get GPA, as one of the other pieces of data.

Ms. Jackson:
We don't technically have GPA, and if I give you a GPA the Dean will probably have a problem with that, the Dean of undergraduate studies, so I don't know if I can do that. I can check with him and see, well, you know, we don't have a GPA, but we do. We can calculate whatever you want, so, but it's not on a transcript or anything.

Connor:
Unfortunately, most of our other data, because it's gonna have to be anonymous, we can't survey effectively, so would there be any way for this office to get information about club officer-ships or leadership positions on campus or honor societies?

Ms. Jackson:
We don't code that here, so probably not.

Connor:
The Student Activities Office, and the Greek houses some of which are honor societies, I know that's probably not the Registrar's Office specifically, but the Student Activities Office would be keeping track of clubs and sports. So if we talked to them do you think they'd be able to share information?

Ms. Jackson:
Well the thing is if they code it. I do know that they code Greek life because we used to provide grade stuff to them because students have to have minimum requirements. I know that's coded, but club stuff I don't know if that is. If it is, yes, we can get it. And we wouldn't really need their permission but we might want to check with them just so we're all on the same side.

Connor:

That would be helpful. And if there's any worries about the anonymity of that, because someone might have a problem with us being able to work backward from people's specific positions, if we even got information not about the clubs themselves but just if they have a leadership position.

Ms. Jackson:
I don't even know if that's coded. I'm thinking that's not coded but you could check with them. What is Ed going to give you? What is your time frame here?

Connor:
So we're looking at students who have participated in FIRST Robotics during high school and he guaranteed the last two years, he thinks he can get us three or four, or even five.

Monika:
It was only very recently that they started keeping track of who was in FIRST in high school.

Ms. Jackson:
I was thinking graduation rates, if you only have two years, would not be that useful.

Connor:
Right, which is why we were thinking dropout rates as well because then we would have information about current classes as well as graduation classes. So we wanted to keep track of that.

Ms. Jackson:
Do you know how big the number is? Of how many people who have participated in FIRST?

Connor:
It's approximately 10% of the population I believe? It's pretty significant.

Ms. Jackson:
Oh, that's not bad, we can definitely get this together.

Connor:
He's not sure exactly what information he can get us he said it would definitely have to be anonymous, but we're also looking to get data beyond that. What we want to do is try to build a predictive model of non-FIRST and then see of that model works for other students, so depending on how much data we receive, 3 or four years might be enough. More is better because we can always just not use what we don't need. So the idea is we get that and then we make a model to predict it and then we plug the first students into that model, presumably the model is working. If we plug the FIRST students in and they are doing better than we expected them to, or worse, or the same, then we've got a conclusion there.

Ms. Jackson:
I think this is definitely do-able. So the judicial students, I bet there aren't and we have so few. (And I just thought of it because a father emailed me he's like 'my son's not allowed to return to WPI' and I'm like 'what are you talking about', cause I looked up the academic standing and he's in good academic standing,

and it turns out it was judicial. I don't handle the judicial student affair side, so I sent it over, I'm like, 'hey, respond to this father') But it is coded, so we may be able to pull it out. I doubt that any of the people you'll be looking at would be in that category.

Connor:
And even if we ignored the judicial ones, it's a very small number of people, it wouldn't really be significant.

Ms. Jackson:
When do you need this?

Connor:
So our IQP is going through B and C term, so sooner rather than later, but it doesn't have to be a rush job and if we can get a little more information by waiting a week or so then that would be fine.

Ms. Jackson:
So what I'll need to do is I'll need to talk to Sarah, she's our information analyst, I'll send her an email today, and say that I met with you guys and that you met with Ed and that maybe she can get together with me and Ed and start pooling data and go from there. Then we can send you stuff and you can take a look and see what you think.

Monika:
One more thing, if we cannot get GPA, would it be possible to keep track of students who have been on the Dean's List?

Ms. Jackson:
Definitely. I'll put GPA and/or Dean's List down, it's a great idea. The GPA stuff is crazy. My office got in trouble, the Dean, somebody had told the Dean that we were providing GPAs like to anyone who called, which is absolutely not true. I'm very very like, protective of student data, as you know, cause I'm like, 'No, I'm not giving you anything that could be student specific data' so when I heard that I was like 'We don't do that' so now I'm like extra paranoid about giving anything. Since it's for an IQP I can check.

END