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ACT Score and College Success: A Predictive Study

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ACT Score and College Success: A Predictive Study

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ABSTRACT

This study analyzed the effectiveness of certain academic and personal factors such as: ACT score, College Credit Plus status, declaration of a STEM major, and the reception of scholarships to predict a student's academic success in college. Academic success was measured as receiving a passing grade (A – C) in an entry level statistics class. The hypotheses were the higher a students' ACT score the more likely they would be to succeed and College Credit Plus and STEM students would also be more likely to succeed than those students not enrolled in the programs. After an analysis including 1349 students, the results of the study indicate that not only are students with high ACT scores more likely to succeed, so are those who are enrolled in College Credit Plus and those in a STEM major. Other factors like age and gender also proved to be statistically significant in these analyses. Colleges and Universities could use this information to further provide necessary support and allocate resources to those students identified to be less likely to succeed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

CHAPTER 1: INTRODUCTION

Introduction

The ACT (American College Test) and SAT (Scholastic Achievement Test) are standardized tests given in the United States that serve as tools of assessment for college admissions. The ACT includes timed, multiple-choice sections in four different subject areas: math, English, reading, and science (ACT, 2018). The SAT has timed, multiple-choice sections in the areas of math, reading, and writing (SAT, 2018). The tests are usually taken by high school students to asses student readiness for college. Many colleges use these tests as a criterion for admissions, often setting a minimum score needed for enrollment. As such, much emphasis is placed on performing well on these tests.

Due to an increase in demand for college graduates in today's workplace, there is an increasing emphasis being placed on college success. College enrollment is higher than it has ever been before and is only continuing to grow. Because of their application and widespread participation, the ACT and SAT are excellent instruments in the prediction of success in college. This study will utilize those instruments and examine the relationship between students' ACT/SAT scores and their success in college; primarily, this study will analyze the ability of the ACT/SAT math component score to predict students' success in college math courses.

Background of the Problem

In today's society it has become almost a necessity to have a college degree and, because of that necessity, an increasing emphasis is being placed on success in college. In attempt to help students succeed, colleges are trying to identify factors that are indicative of success before a student even sets foot on campus. Many studies have been conducted to identify these factors, and the three that most often surface are: ACT score, SAT score, and high school GPA (HSGPA). In these studies, it is often found that, on some level, ACT score, SAT score, and HSGPA are statistically significant predictors of college success, where college success is typically measured by a grade in a particular class or by GPA (Bleyart, 2010; Curabay, 2016; Focareto, 2006; Gregory, 2016; Noble & Sawyer, 2002; Sun, 2017).

While all three factors are considered to be significant predictors, there is much debate about which factor is the most effective predictor. The argument involves not only the strength of the correlation between the factors and success, but also the different elements each factor measures. Many studies show support for HSGPA being the most significant predictor of college success (Belfield & Crosta, 2012; Focareto, 2006; Sun, 2017**)** and some studies suggest that a combination of standardized test score and HSGPA is the best predictor (Bleyaert, 2010; Curabay, 2016; Gregory, 2016; Noble, Sawyer, 2002). Almost no studies have shown with significance that ACT or SAT score alone is the best predictor of college success. The differing factor between the two schools of thought is the notion that success is not dependent on intellect alone and relies on noncognitive factors as well (Noble & Sawyer, 2002).

ACT and SAT scores are commonly accepted to be accurate indicators of student intellect, but the use of HSGPA as a measure of noncognitive factors is highly debated. While HSGPA does, to some degree, take into account facets of success such as effort, determination, and attitude, the severe lack of standardization across the country calls to question the accuracy of HSGPA as a numerical predictor (Gregory, 2016). Individual schools are able to determine their own scale of measuring GPA, which causes a discrepancy when attempting to compare GPAs. In conjunction, grades are subjective to the grader and grade inflation is a large factor in the analysis of GPAs (Focareto, 2006).

A common element of these studies is that they use composite ACT/SAT score to predict college success. The issue with this is the notion that success is comprehensive and success in one academic area implies success in other academic areas, which is not the case for many students. A study by Sun shows that individual ACT component scores are significant predictors of college success (Sun, 2017). Predicting success within an academic area may be a more accurate measure of student success. This study aims to determine if individual component scores of standardized tests are significant predictors of college success by comparing test scores, college grades, and GPAs within the same academic content areas.

Statement of the Problem

Much research is being conducted to identify predictors of college success. In these studies, ACT and SAT composite scores are used to predict overall college GPA. A different approach would be analyzing component scores, which can be effective at using student's strengths to predict success. This study will analyze the ACT and SAT component scores to determine if they are effective predictors of success in a college course in the same content area. These predictions of success will allow colleges to accurately place students into courses and to identify a need for different or additional support measures.

Purpose of the Study

This study implements a quantitative research design in attempt to identify independent variables such as ACT score, SAT score, and HSGPA that effectively predict a student's success in college. ACT score, SAT score, and HSGPA were chosen as predictor variables because they are all numerical quantities that attempt to quantify a student's high school success. Specifically, ACT and SAT scores give a numerical value for a student's intellect while HSGPA gives as best a numerical value as possible for the more abstract factors of success such as effort. College success will be measured by final numerical grade in a particular college course and freshman year GPA, as these variables give the best quantification of college success.

The population of the study are students at Shawnee State University (SSU). The study includes individuals of all ages, from different cultures and backgrounds. The participants are both male and female and are comprised of a variety of races and socioeconomic situations. The study was conducted entirely at Shawnee State University in Portsmouth, Ohio.

Significance of the Study

We now live in an "obligatory world of education," where going to college is a near certainty for graduating high school seniors (Focareto, 2006). Students spend months researching, visiting, applying, and waiting to hear back from their "dream school." However, simply going to college is not enough; students must thrive and succeed, and colleges are expected to do everything they can to help students achieve success. When looking at success, the strongest predictor of academic achievement is previous achievement (Grinstead, 2013). Students pursue higher education to obtain advanced knowledge in a particular field of study; the best predictor of their success in a specific academic area is their previous performance in that academic area. Previous studies have attempted to help predict success by looking at overall test scores and overall GPA, a strategy that leaves questions about success in a specific content area unanswered. This study will help answer those questions by analyzing student ACT and SAT component scores and predicting student success in a corresponding academic area.

After reviewing the results of this study, colleges will be able to more accurately place students in entry level courses and better identify students who are at risk for failing. If the results of this study indicate that component scores of standardized test scores are significant predictors of success in comparable college courses, colleges can use those scores to accurately place students in classes at a level at which they are most likely to succeed. They will also be able to identify students who are at risk for not succeeding and provide them with resources to aid in their success.

Primary Research Questions

The main purpose of this study is to analyze ACT/SAT math component scores and their ability to predict success in college math courses. However, this study will also examine other factors that may be effective in predicting college success. The research questions this study aims to answer are:

1. Do students with higher math ACT/SAT component scores earn higher final grades in entry level college mathematics courses?
2. Do students with higher math ACT/SAT component scores have higher freshman year GPAs?
3. Are students with higher math ACT/SAT component scores more likely to take STEM-tracked college math courses?
4. Are students with higher English and reading ACT/SAT component scores more likely to take non-STEM-tracked college math courses?
5. Are students will Pell Grants more likely to take STEM-tracked college math courses?

Hypotheses

All hypotheses will be tested twice. Once with ACT score as the independent variable and once with SAT scores as the independent variable. The hypotheses are:

1. There is a correlation between math ACT/SAT component scores and final grades in entry level mathematics courses.
2. There is a correlation between math ACT/SAT component scores and freshman year GPA
3. There is a relation between math ACT/SAT component scores and enrollment in a STEM-tracked entry level math course.
4. There is a relationship between English and reading ACT/SAT component scores and enrollment in a non-STEM-tracked entry level math course.
5. There is a relationship between Pell Grant status and enrollment in a STEM-tracked entry level math course.

Research Design

The data for this study will be obtained from a database maintained by SSU. The study will include all freshman students that were enrolled in a math class at SSU from the years 2012-2017. The students included in the study will have also have a recorded ACT or SAT score and a high school GPA on file with SSU. Data obtained will include a student's: age, gender, socioeconomic status, ethnicity, ACT or SAT score and sub scores, freshman year GPA, entry level math course taken, final grade, professor, and Pell Grant status. Multiple statistical tests will be run to determine if ACT component, SAT component, or HSGPA are significant predictors of final math grade or freshman year GPA. Each variable will be tested individually and in conjunction with other variables.

The instruments used in this study will be ACT score, SAT score, and HSGPA. When used to measure student intellect, ACT and SAT can be found to be valid and reliable. They both produce consistently accurate results in measuring student intellect in designated material. The uncertainty in validity comes when the tests are used as measurements outside of their original intent, such as measuring success, which is not a well-defined term. HSGPA is neither valid nor reliable. Not only are the measurement procedures encompassed in the calculation of HSGPA inconsistent across the field, but they are also intended to measure success, which again is not a well-defined term.

Theoretical Framework

Before standardized tests, most colleges had their own individual admissions tests and were mostly interested in testing mastery of previously learned material. The Scholastic Aptitude Test (SAT) was developed primarily by Carl Brigham and was first given in 1926 as more of a measure of aptitude for learning than mastery of subjects already learned (Jacobson, 2017). In response to the SAT and its primary use in the northeastern United States, the American College Test (ACT) was created as a means for more students to seek admissions to less selective universities (Jacobson, 2017). The original intent of the ACT was to be used "not just for admissions but for placement as well," as it was an achievement test designed to test academic preparation (Jacobson, 2017).

Over the past 92 years, both the ACT and SAT have grown to a level of national prominence. In 2016 approximately 3.73 million students combined took either the ACT or SAT, with 25 states requiring the completion of at least one of the tests for high school graduation (Adams, 2017). Both tests are also eligible to be used as academic indicators for accountability on national education standards for all US high schools (Klein, 2016).

While there has been a large increase in the number of student test takers, these standardized tests seem to now be used almost solely for admissions purposes, which raises the question as to whether academic institutions have strayed from using these tests to measure aptitude for learning and as a guide for course placement as they were originally intended. Although the use of standardized tests for admissions criteria is necessary to compare applicants, these standardized tests can serve a larger purpose. This study intends to show that the ACT and SAT can be used for their original purposes, and can help colleges identify students who have an aptitude for success and accurately place those students into appropriate entry-level classes.

Assumptions

1. All test scores obtained from the data base are the most current and highest scores achieved.
2. All GPAs are measured on the same scale.
3. Every student completed their best work on all tests and in all classes.
4. All students were taking these classes for the first time

Limitations

One of the largest limitations of this study is that all of the students attend SSU. A more thorough study would include other colleges and universities. Another factor that will limit the outcomes of this study are the situational and dispositional variables that cannot be accounted for. There are many sources of influence for college students, including, but not limited to, personal relationships, motivation, and amount of study time. These influences are extremely difficult to account for mathematically and, therefore, will not be included in this study. However, these influences could unknowingly affect the results of the study.

Scope

Because of the widespread participation in the ACT and SAT tests and the standard use of HSGPA, these results will be applicable all colleges and universities within reason.

Delimitations

The most influential delimitation of this study is that it was conducted entirely at SSU. This was done out of convenience and the availability of data. Another delimitation is the sole use of Freshman students. This was done in attempt to control for the change in student behaviors throughout college.

Definition of Terms

ACT: A national standardized test used for college admissions in the United States (Originally the American College Test).

College Credit Plus: Abbreviated CCP, College Credit Plus is a program where high school students can take a class through an accredited university and receive college credit

Component ACT Score: The breakdown of a student's ACT score into achievement in the individual academic areas of: Reading, English, Mathematics, and Science Reasoning

Component SAT Score: The breakdown of a student's SAT score into achievement in the individual academic areas of: Reading, Writing and Language, and Mathematics

Composite ACT/SAT Score: The numerical combination of a student's component scores in the individual academic areas of the given test

Grade Point Average (GPA): A numerical representation of the averages of accumulated final grades in all courses earned over a given period of time.

Non-Cognitive Factor: An element related to a student's skill regarding motivation, integrity, and interpersonal relationships separate from a student's intellect that plays a role in academic achievement.

Pell Grant: A federal grant available to students of eligible financial need in order to fund undergraduate studies

SAT: A national standardized test used for college admissions in the United States given by the College Board (Originally the Scholastic Aptitude Test)

STEM: STEM stands for Science, Technology, Engineering, and Mathematics and represents a national initiative to get students to participate in these subjects at both the high school and college levels

Summary

With college enrollment at an all-time high, it is more important than ever for colleges and universities to be able to accurately identify students who are likely to succeed and those who may require more resources. This study will analyze component ACT and SAT scores and compare them to student grades in corresponding college academic content areas. The results of the study will help determine if ACT and SAT component scores are significant predictors of college success and ultimately help colleges accurately place students into entry level courses and determine students who are at risk for failing.

CHAPTER 2: LITERATURE REVIEW

Success is an important topic in the college world. Colleges are judged upon how many of their students graduate and how those students perform along the way. Several researchers have attempted to maximize student performances by analyzing the factors that best predict success in terms of graduation and performance. In most studies three main predictors are established. From the beginning HSGPA and standardized test scores have emerged as the two most important predictors of college success. As such, there is a long-standing debate as to which is the best predictor. From these studies a third predictor arises. Non-cognitive factors, while seen as less important than HSGPA or standardized test scores, play a significant role in the prediction of success. Reviewing the current literature available on these three predictors is essential to understanding their interactions and for further analysis.

In the ongoing debate between HSGPA and standardized test scores, the research study of Geiser and Santelies (2007), which compares the use of HSGPA and standardized test scores in predicting college success, takes the stance that not only is HSGPA a better predictor of freshman year success, but HSPGA actually becomes a more accurate predictor of success in college years 2-4. The authors conducted a qualitative analysis on existing data from the University of California Education system. In their research, they showed that due to the drop out of under achieving students, the average cumulative GPA of college students increases throughout a four-year college program. When looking at HSGPA, SAT scores, and SAT subject test scores, the factor that alone most accurately predicted the students who would drop out was HSGPA. Overall, the best predictor was a combination of HSGPA, SAT Writing, along with a collection of non-cognitive factors including parent education and family income.

The authors make significant mention that their findings go against the widely popular notion that standardized tests are better for assessing student ability and achievement. This seems to be the largest factor in motivation for their research, even though their opinion seems to be more supported in research than they would be led to believe. The literature used to evaluate their claim largely supports standardized testing and seems to be presented in a negative light to bolster support for their claim. Even though the inclusion of literature is limited, the authors are justified in their research as the debate between whether HSGPA or standardized test scores are better at predicting success is one that is always ongoing and new research and opinions are always encouraged. The findings are based in sound logic and the authors make a convincing argument that HSGPA is a better predictor of success than SAT scores. However, the fact that their best predictive model included a combination of HSGPA and SAT scores along with non-cognitive factors suggests that success is not as cut and dry as is suggested.

While Geiser and Santelies argue that HSGPA is clearly the best predictor, an article by Noble and Sawyer (2004) argues that there is not one clear winner in the HSGPA vs. standardized test score debate. Their study shows that the best predictive model is actually dependent on the definition of success. Success is a difficult concept to define and its definition varies greatly among studies on the topic. While most researchers try to define success and stick with one definition throughout their research, these authors did a study on the predictive power of HSGPA and ACT scores based on varying levels of success in college. The study breaks down freshman year GPA (FYGPA) from 2.0 - 4.0 into 6 increments and determines the percentage of students that accurately achieved these levels of FYGPA based on different predictive models using HSGPA and ACT composite score as factors.

Their findings bring an interesting idea to the table that HSGPA is better at predicting which students will achieve a lower FYGPA (2.0 – 3.0) and ACT composite score is more accurate at predicting success at the FYGPA of 3.0+ levels. The authors state that the most important result of their research is " .. the apparent inability of HSGPA to predict high levels of academic achievement in the first year of college" (Noble; Sawyer, 2004). The article cites other research that explores the relation of non-cognitive factors to success and while it was not the original intent of their research the authors concede that non-cognitive factors are significant contributors to academic success especially at the lower levels (< 3.0).

Even though the authors acknowledge the role of non-cognitive factors, their qualitative study on existing ACT data shows that at some level of significance ACT composite score is an accurate predictor of first year college success while HSGPA is not. Their research includes a combined model of ACT composite score and HSGPA that actually provides the most statistically significant prediction. However, in the debate over HSGPA and standardized test scores, these authors make a definitive stance in the support of standardized test scores.

In an attempt to find reasoning behind the factors in the HSGPA vs. standardized test scores debate, Chapter 6 in a book on the intricacies of completing college at America's public universities published by authors Bowen, Chingos, and McPherson (2009) specifically looks at test scores and HSGPA and their relation to college success. The focus of the book is completing college, so here, success is defined as graduating from a 4-year program within 6 years. After looking at data from nearly 150,000 students, the authors confidently conclude that the strongest single predictor of graduation is HSGPA. The results support that this is largely due to the ability of HSGPA to measure certain non-cognitive factors, a topic to be discussed in a later section of this report.

The research shows that alone, HSGPA is the most significant predictor, although a model using both HSGPA and standardized test scores is a better predictor of college success (as measured through graduation). However, this seems to be due to the fact that standardized test scores are less of a measure of student ability and more of a measure of the caliber of high school a student attended. This is endorsed by a model run in this study that grouped high schools by academic prestige and then controlled for those different groups when examining the predictive power of HSGPA and standardized test score. The research showed that standardized test scores were not significant predictors across any level of high school.

Even though the authors are largely in support of HSGPA as a predictor of college graduation, they also acknowledge the areas in which standardized test scores become a more prominent tool of measurement. While standardized test scores are a relatively weak predictor of success when looking at graduation rates, when the focus of success is shifted to college grades, the standardized tests have a substantially larger power of prediction, especially when examining the most selective colleges. This is indicative that although HSGPA is the best at predicting who will make it to graduation, standardized tests are better at predicting who will do better along the way.

No matter how you define success, it seems clear that both HSGPA and standardized test scores are strongly correlated to success in college. What also seems clear is that there are many other factors that contribute to success that these studies briefly mention but never fully address. Most of these factors can be classified as non-cognitive skills, or skills that are not directly related to intelligence and intellect including traits such as motivation, and attitude. When looking at success it is extremely important not to overlook these factors as they play a much larger role than most would suspect.

Most non-cognitive factors are classified as intrapersonal skills or skills that occur within oneself. In relation to academics, these are often related to motivation, attitude, and study habits. A study done by Ashley Cooper in 2014 analyzes these intrapersonal non-cognitive factors and their role in predicting college success. As a psychology student, Cooper was less interested in which cognitive factors (namely ACT score or HSGPA) provided a better predictive model for college success, and more interested to see how non-cognitive factors such as grit, goal orientation, and academic self-efficacy influenced student success. This qualitative study compared two models that predicted college success. One model was composed of HSGPA and ACT composite score and compared predicted FYGPA to actual FYGPA. The second model was again composed of HSGPA and ACT composite score but also included measures of the non-cognitive factors obtained through a series of surveys.

As stated before, a large amount of research is available on the comparison of different cognitive factors in predicting college success. Cooper evaluates this literature in her article noting that several of the cited works state that at some level non-cognitive factors play an important role in predicting success. This seems to be the driving force in her research, a justifiable attempt to answer a question that is frequently brought in up research but rarely addressed. While the use of only one college in her study limits the results of the research, the findings are significant and support the use of non-cognitive factors in predicting success. The research shows that, in the second model, the addition of the non-cognitive factors is statistically significant and improves the rate of prediction by over 2%. The most interesting finding of this study is that, when predicting dropout rates, the most significant factors are goal orientation and consistency of interest, stating that “Personal preference for long-term goals is positively associated with academic performance” (Cooper, 2014). In fact, the study found that when predicting intent to leave a college or university, HSGPA and ACT composite scores provided no statistical significance.

While this study shows that non-cognitive factors are significant at predicting dropout rates and they improve the models of academic success, an overlooked fact is the research shows that 35% of variance in prediction can in fact be accounted for by cognitive factors. So, even though this study aims to show that non-cognitive factors are important in predicting college success, which they are, the study also shows that cognitive factors are far more important than non-cognitive factors alone.

As mentioned earlier, the book written by Bowen, Chingos, and McPherson (2009) states that HSGPA is the most significant indicator of six-year graduation rates. The research of the study allows readers to interpret that this is because, on some level, HSGPA is a measure of certain non-cognitive factors. This is because HSGPA can reveal a student's mastery of content, their motivation, and perseverance, rather than a student's ability to prepare for a test.

The best illustration of this is shown through the classification of high schools into different groups based on academic prestige. When the authors ran an analysis on the predictive power of HSGPA across high school groups, they found that "HSGPA is a relative predictor no matter the level of high school attended" (Bowen; Chingos; McPherson, 2009). This shows that students at low performing, disadvantaged high schools with high HSGPAs have a better chance of graduating college than students at well-funded, high performing high schools with low GPAs. At first, it may seem this is contrary to the argument that non-cognitive factors play a role in college success, and, in fact, it is when considering race/ethnic and SES. However, when looking at other non-cognitive factors such as drive, determination, and work ethic, this research is in strong support that these factors play an extremely important role in predicting student success.

The study goes on to explain how HSGPA is an excellent measure of a student's ability to "get it done" (Bowen; Chingos; McPherson, 2009) and that the ability for a student to consistently meet a standard of performance is more important than the actual academic level of that importance. HSGPA aside, the fact of the matter remains, no matter the form of measurement, non-cognitive factors are relative at every level and within every aspect of academic success.

While most non-cognitive factors are seen through intrapersonal skills, non-cognitive factors can also be external influences. One author, Edgar Sanchez (2013), completed a study that not only compares HSGPA and ACT composite score and their ability to predict FYGPA, but that actually focuses on showing the effects of these predictions across different racial/ethnic groups, genders, and income ranges. The study looked at HSGPA and ACT composite scores broken into different subgroups of race/ethnicity, gender, and income. A certain score or GPA was established as the point of predicted success in each of the categories and then was compared against actual success outcomes. The drive for this research comes from the analysis of literature on ACT scores. The author notes that scores are highly variable across these different groups indicating that ACT score is not a wholistic measure of academic ability as there are certain non-cognitive factors that play a role in scores. The author seems motivated to show that even though students may be predicted to obtain a certain level of success based on HSGPA and ACT scores, different subgroups of these students adhere to these predictions with varying levels of accuracy.

This study shows that the subgroups of students predicted to have the lowest level of success as shown by FYGPA based on qualitative analysis done on HSGPA and ACT composite scores are African Americans, Hispanics, and low-income students. It was found that African American students that had a 4.0 HSGPA had a less than 40% chance at obtaining a 3.0 or greater FYGPA as compared to approximately the 75% chance their white counterparts had. While the author does not make it clear if this discrepancy is due to inflated predictors such as HSGPA and ACT or a decreased opportunity of success in college, the point the author does make clear through his research is that non-cognitive factors play a significant role in predicting success at the college level.

Even though non-cognitive factors are significant predictors of success at the college level, cognitive factors are substantially larger factor in that prediction. Non-cognitive factors improve prediction models, but the majority of the statistical significance comes from the cognitive factors such as HSGPA and standardized test scores. However, these cognitive factors, even though statistically significant, still leave a large portion of variance to be accounted for in predictive models. A further analysis of these cognitive factors and the breakdown of standardized test scores into component scores can be used to further improve predictive models.

In attempt to find a way to improve college retention and performance, Bettinger, Evans, and Pope (2013) conducted a study that went against the conventional methods of predicting college success. Most colleges use ACT composite score as an admission criterion and an indicator of student achievement. However, the authors of this study propose that instead of using ACT composite score, schools should look at ACT component scores, specifically the English and Math sections, to improve the likelihood of admitting students with the highest chance of succeeding (Bettinger; Evans; Pope, 2013).

The authors ran a qualitative analysis on data from 13 Ohio state colleges, in which the study shows the correlation between FYGPA and ACT composite and component scores. Upon analysis it is seen that a 1-point increase in ACT composite score results in a 0.072-point increase in GPA. As this is broken down into component scores, English and Math both account for approximately .035 each and Reading and Science combine for the remaining .002. From this it is easy to conclude that ACT Math and English component scores have a large and significant effect on FYGPA whereas ACT Science and Reading component scores do not. In fact, this study shows that when controlling for Math and English scores, Science and Reading ACT component scores have no predictive power over FYGPA.

Bettinger, Evans, and Pope focus on showing the conventional methods of using composite ACT score can be ineffective at predicting student success by analyzing dropout rates and their comparison to ACT component scores. The research shows that a student who receives a 24 composite ACT score by achieving 26 Reading and Science component scores and 22 English and Math component scores is 59% more likely to drop out in the first year as compared to another student receiving a 24 composite ACT score but by achieving 22 Reading and Science component scores and 26 English and Math component scores.

It is interesting to note that even with these findings this study still acknowledges that when acting alone HSGPA is still the most significant predictor of college success, but it is a combination of HSGPA and standardized test score that provides the best model of predicting success. Regardless, this study still brings new light to a topic that has been debated for a long time. It is the findings of this study that provide substantial motivation for the current study.

Even though ACT component scores can be an excellent tool for college admissions, they can also be used to predict success in college classes. A study done by Allen and Sconing (2005) took a similar approach and used ACT component scores in attempt to define success in different college classrooms. The authors of this study took qualitative data from several colleges across the united states and compared the ACT scores of students that received a B or higher to those of students who received less than a B in certain first year courses. The data was averaged and a cutoff score was established; the cutoff being the median ACT score at which a student had at least a .50 probability of receiving a B in the designated course.

This study brings two important factors to light. The first being the definition of a .50 probability of achieving B or higher as the mark for success. This is significant because although most studies establish a mark for success, this is one of few studies that provides a sound reasoning for their definition of success. Approximately 50% of all students in first year college classes receive a final grade of a B or higher (Allen; Sconing, 2005), so a 50% chance of obtaining a B or high is congruent with current standards. The second important factor is the use of ACT component scores in comparison to college classes of the same content area. The study acknowledges the notion that students excel in different areas and this notion allows predictions to be made outside conventional methods. By only focusing on comparisons within content areas, students who are most likely to succeed in those particular areas can be identified, rather than being identified to not succeed when looked at holistically.

The research in this study actually contradicts the findings in the previous study. Allen and Sconing establish a benchmark score of 24 on the Science ACT component and 18 on the English component as the threshold of a 50% chance of success. This means that a student has to score significantly lower on the English section to have the same chance of success as in the Science section. This would indicate that either college science courses are much more difficult than college English courses or that English component score is significantly less of a predictor of success than the Science component score; the direct opposite of previous findings.

While the findings may contradict each other, what does remain true is that both studies find that breaking scores into components rather than looking only at the composite scores, is significant in the prediction of success.

After reviewing the plethora of research on predicting college success, a few things became clear. While there is debate as to which individual factor is the best predictor of success, the best model includes a combination of HSGPA and standardized test scores. HSGPA measures non-cognitive factors and these factors play a role in a student's ability to achieve success, though less of a role than cognitive factors. While standardized test scores are significant in the prediction of success, examining the individual component scores has proven to be even more affective in college admissions. This current study will further examine the effects of examining standardized test component scores and determine their ability to predict success in corresponding content classes.

CHAPTER 3: METHODOLOGY

From the review of literature, it is clear that the success of college students is dependent on more than one factor and the definition of success is quite variant. As this study is trying to determine exactly which variables effectively predict a student's success in college, it is important to understand the correct methods and tools needed to accomplish this task. In an attempt to further examine these relationships, a thorough and thoughtful approach must be taken in order to fully understand the data and to plan the most effective analysis.

First, it is important to understand the data. This study is being conducted on the campus of Shawnee State University (SSU). SSU was founded in 1986 and is classified as a small public Midwest university located in Portsmouth, Ohio. Approximately 3,400 students are enrolled at SSU with 54% being female and 46% male. Portsmouth is a relatively small town consisting of about 20,000 residents. Of these residents almost 91% identify as white, 62% are aged 18-64, and 53% are female. SSU is the only college/university located in Portsmouth (Shawnee State, 2019).

This study will aim to be generalized to all universities in the United States of a similar size and academic caliber. This study includes factors that are relevant to most universities. Most universities have a somewhat diverse group of students that are capable of achieving different levels of success. Predicting that success and maximizing resources is a common objective for many of these universities. While it may not be an exact match, the results of this study can generally be applied to most universities.

When analyzing data, it is also important to make sure the data was collected using the correct tools. The first instrument used in the collection of this data is the American College Test (ACT). The ACT is a standardized test given to high school students across the United States primarily used for college admissions. The ACT consists of four sections in the content areas of: Math, English, Reading, and Science with an optional writing portion. The Math section contains 60 questions and comes with a 60-minute time limit. The English section has 75 questions that are to be answered in 45 minutes. Both the Reading and Science sections each have 40 questions and a 35-minute time limit. Each section is scored on a scale of 1-36 and the four component scores are then averaged to form an overall composite score also on a scale of 1-36. The ACT was established in 1959 and has only grown since (Jacobson, 2018). Almost 2.1 million students took the ACT in 2016, solidifying its national prominence (Adams, 2018) . The ACT is an extremely reliable instrument. The ACT produces similar results under the same conditions and scores are consistently reproducible across different testing periods.

Another instrument used in the collection of data for this study is the SAT. Originally called the Scholastic Aptitude Test, later changed to the Scholastic Achievement Test, and now simply just called the SAT, the SAT is another standardized test given to high school students across the United States that is primarily used for college admissions. The SAT serves a very similar purpose to the ACT, but the make-up of this test is slightly different. The SAT consists of three sections in the areas of: Reading, Writing and Language, and Math with an optional essay section. The Reading section consist of 52 questions to be completed in 65 minutes. The Writing and Language portion of the test has 44 questions and a 35-minute time limit. The Math section has 58 questions to complete in 80 minutes, but unlike the ACT the SAT Math section has two portions, a calculator and a non- calculator section. The Sat is scored in 2 sections, Math and Evidenced Based Reading and Writing. Each section is scored in 10-point increments on a scale of 200-800 points, with a total possible score of 1600. The SAT was first given in the year 1926 as a way to measure aptitude of learning (Jacobson, 2018). Over 1.64 million students took the

SAT in 2016, one of the highest ever totals (Adams, 2018). The SAT is also an extremely reliable instrument. It produces consistent and similar results and scores are considered a standard unit of measurement across different tests.

The third instrument used in this study is Grade Point Average (GPA) at both the high school and college levels. GPA is a numerical indication of a student's current and past academic achievement. There is not a national standard for GPA and therefore a large assortment of GPA scales and measuring techniques exist. The most common scale for GPA is a 0 – 4 scale with 4 representing an A average across all courses, 3 representing a B average, 2 a C average, and 1 a D average. Some institutions also weight the difficulty of classes which introduces 0 – 4.5 scales and 0 – 5 scales. Some institutions, mainly colleges, also place weight on the length of the class. A grade in a 5-credit hour class would have a larger impact on GPA than a 2-credit hour class. Since there is no standard GPA each school has the freedom to establish their own scale and criteria for GPA. Also, since GPA is based on grades and grades are given based on the subjectivity of instructors, even within schools that share the same GPA scale, the criteria for different GPA's can be drastically different. With this non-standardization, GPA is not a reliable instrument of measure. Scores are not easily replicable and are not consistent across different sources.

The data for this study was previously collected by SSU and obtained via Dr. Darbro. This study received full approval from the SSU IRB on 11/30/2018. The study was approved as an expedited study as there was no risk to participants. During this study, the confidentiality of recovered data will be maintained at all times, and identification of participants will not be available during or after the study.

The second step in conducting an effective analysis is using the correct methods. This study will aim to answer the following 5 research questions.

1. Do students with higher math ACT/SAT component scores earn higher final grades in entry level college mathematics courses?
2. Do students with higher math ACT/SAT component scores have higher freshman year GPAs?
3. Are students with higher math ACT/SAT component scores more likely to take STEM-tracked college math courses?
4. Are students with higher English and reading ACT/SAT component scores more likely to take non-STEM-tracked college math courses?
5. Are students will Pell Grants more likely to take STEM-tracked college math courses?

Each research question will be analyzed individually and three different analysis methods will be utilized. The descriptives of the data will be presented in Chapter 4 in correspondence with the information needed for each of the different statistical tests.

The first two research questions will be analyzed using a multiple regression analysis. This study will focus on overall correlation between standardized test scores and grades/GPA's rather than establish a set success/failure point. Many of the reviewed studies used logistic regression as they had a dichotomous variable of success failure (Allen, Sconing 2005; Noble, Sawyer 2002; Sanchez, 2013) since this study will use continuous variables a multiple regression is more appropriate. In both questions the main independent variable will be ACT/SAT score. Other independent variables will include HSGPA, age, gender, race, and SES status. In research question #1, the dependent variable will be final grade in an entry level college math course, while it will be final FYGPA in research question #2. An original model will be created using ACT/SAT score to predict the dependent variables. Subsequent models will then be created by adding in and removing the other independent variables to find the model that shows the best prediction between the independent and dependent variables.

The second two research questions will be answered using a logistic regression model. As previously stated, many studies have used this approach in determining an achieved level of success. In a similar manner, this study will conduct a logistic regression where the dichotomous dependent variable will be enrollment in a STEM or non-STEM math class for both research question #3 and #4. The independent variables will be mostly the same between the two research questions with the difference being question #3 will use ACT/SAT math component scores and question #4 will use ACT/SAT English and reading component scores. The analysis will also use HSGPA, age, gender, race, and SES status as independent variables.

The only variables that will be used in the analysis of the final research question are Pell Grant status and enrollment in a STEM or non-STEM math class. Since both of these variables are dichotomous the best way to determine their relationship is a Chi-Squared test of Independence. The dependent variable in this analysis will be STEM enrollment while the independent variable will be Pell Grant Status.

Since success is such broadly defined term, it is important that many questions be analyzed in several different ways. The methods of this study are designed so that analysis of each research question will provide insights to the relationships between each factor included in the analysis and success. This study will seek to answer those research questions using the results of the analysis.

CHAPTER 4: RESULTS

After preliminary research and investigation, the data that was obtained for this study did not lend itself to answer the originally proposed research questions. Due to the limited availability of data and a condensed time frame the new research questions were posed so that an analysis could still be conducted and results still obtained. The new research questions are as follows:

1. Do students' ACT scores indicate whether they will pass an entry level math course or not?
2. Are College Credit Plus (CCP) students more likely to pass entry level math courses than traditional students?
3. Are students in STEM majors more likely to succeed in entry level math courses than their Non-STEM counterparts?
4. Are students who receive merit-based scholarships more likely to succeed than those students who do not?

The original purpose of this study was to identify independent variables that effectively predict a student's success in college. While the lack of desired data does not allow the study to be conducted in the originally intended manner, the purpose of this study to identify student success factors can still be obtained. The results of the study conducted using these new research questions will be presented in this chapter.

The data for this study included 2221 observations all of which were students enrolled in a STAT1150 class at SSU over the past 4 years. The data was obtained from an SSU academic record database. Final grade for the class was recorded on an A-F letter grade scale with + and -. Other student indicators were listed with final grade including: enrollment year, enrollment term, course taken, placement exam score, age, gender, and major. All of this information was used in the following analyses.

Data Cleansing

Overall 808 students were excluded from this analysis for several reasons. 153 students were excluded because they did not receive a final course grade for one of the following reasons: they withdrew, no score was recorded, or they were still in progress of taking the class. 547 students were excluded for having no recorded placement test score and 49 students were excluded for having a placement score other than ACT recorded. Data for students who took the SAT was obtained, but ultimately excluded as only 43 students had recorded scores. It was determined that including these students would not make a significant impact on the study and results obtained would not be accurate due to the low sample size. After these students were removed only 3 students remained from the 15/16 school year; these students were again removed because of the low sample size. Lastly 59 students were excluded because they had multiple data entries indicating they took the class two or more times. These students were removed to preserve independence in the study.

Participant Descriptives

Of the 1349 students included in the analysis 850 (63.00%) were female and 499 (37.00%) were male. The age of students ranged from 14 to 51 with a mean age of 20.78 and a standard deviation of 3.67. The mean age did not vary significantly between females ($M = 20.77$, $s = 3.70$) and males($M = 20.80$, $s = 3.63$; $t(1059.10) = -0.110$, $p = 0.91$). Most students took the regular STAT1150 class, however 38 students were enrolled in STAT1150A, a course that includes extra remediation material for students with ACT scores of 15-17. The mean ACT score for all participants was 21.30 with a standard deviation of 3.88. Over half (52.63%) of the participants took their course in the fall semester. A further breakdown of students by gender, term, and year is provided in Table 1.

Table 1. Participants by Gender across Year and Term

		FA	SP	SM	Total
16/17	Female	163	174	9	346
	Male	80	90	9	179
	Total	243	264	18	525
		FA	SP	SM	Total
17/18	Female	175	130	10	315
	Male	93	92	6	191
	Total	268	222	16	506
		FA	SP	SM	Total
18/19	Female	158	106	0	354
	Male	100	74	0	174
	Total	258	180	0	438

Assumptions

Each research question was analyzed using logistic regression methods. When preforming a logistic regression five assumptions need to be met. Those assumptions are: the dependent variable is binary, observation independence, lack of multicollinearity, linearity of independent variables and log odds, and a large sample size. In the analyses the dependent variables are all dichotomous coded as a 0 or 1 which meets the binary assumption. The assumption of linearity was met as all students included in the analysis took the class just one time and did not interact with any other student observations. Large sample size can be assumed with 1349 participants. The remaining two conditions will be checked within each model.

Data Analysis

Research Question #1

This question was answered using two different methods each with two different parts. First a logistic regression was conducted on the dichotomous variable Pass. This variable was created by grouping students into to two categories based on their final grade. The first group was made up of students who received a C or higher and the second group was students who received a C or lower. Similarly, the variable Fail status was created, however this time a cutoff score of D- or higher was used to indicate passing students and students who received an F were placed in the second group.

Both methods involved a logistic regression in two parts, one part using Pass status as the dependent variable and the other using Fail status as the dependent variable. The first method was to analyze student Exam score as a continuous numeric variable on the 1-36 scale the other method was to convert Exam scores into a dichotomous variable by placing students into one of two categories: above the exam average and at or below the exam average.

When using ACT score as a continuous number to predict Pass status a backwards step analysis of the saturated model revealed the most effective model was to use just ACT score and Gender as the two predictors. It is important to note that while Gender is included in this model (Model 1.1) the mean ACT score did not vary significantly between males and females ($t(971.66) = -0.86$, $p = 0.27$) , with a female mean score of 21.23(3.73) and a male mean score of 21.42(4.07). This model showed statistical significance when compared to the constant only model ($\chi^2(2) = 125.70$, $p < .001$), which means Model 1.1 accurately distinguished the students who passed and those who did not. This model had a moderately high percentage of accurately classified cases (80.87%) at the 0.5 threshold, but had sensitivity and specificity values of 0.986 and 0.054 respectively.

ACT score was separated into two categories using an average score of 21.30 as the dividing point. The cut point of 21.30 was used because it was the average score of all student scores in the study and because it coincides with the national average of 21 (Average, 2016). There were 603 students in the above average category and 746 in the below average category. The backwards analysis using this new variable to predict Pass status also used the predictors of ACT score and Gender, but also added Year as a third predictor. This model (Model 1.2) was also statistically significant against the null model ($\chi^2(4) = 84.00$, $p < .001$). This model did not have very reliable sensitivity and specificity values at the 0.05 threshold (1.000 and 0.000 respectively), however it did accurately classify 1092 of 1349 cases (80.35%).

Both of these methods were also used to analyze the relationship between Fail status and ACT score. As a numeric score, a model with ACT score as the lone predictor was found to be statistically significant in predicting Fail status ($z = 6.90$ $p < .001$). A backwards step analysis was also completed on a full set of predictors to obtain Model 1.3 which used ACT score, Enrollment Year, and Enrollment Term as the predictors that were best able to predict Pass status. This model was statistically significant when compared to the constant only model ($\chi^2(5) = 64.66$, $p <.001$). Using the threshold of 0.5 1228 of 1349 cases were accurately classified (91.03%); However, the sensitivity and specificity values (1.000 and 0.000 respectively) indicate that while Model 1.3 accurately classified a high number of true positives, there were a large number of false positives.

When using the dichotomous ACT scores the backward step analysis concluded a model with the same predictors as the numeric scores (ACT score, Enrollment Year, and Enrollment

Term). The created Model 1.4 was also significant when compared against the null model ($\chi^2(5) = 44.25$, $p < .001$). This model also had a high percentage of accurately classified cases (91.10%), but again had sensitivity and specificity values of 1.000 and 0.000.

Tables 2- 5 show the coefficients, test statistics, p-values, odds ratios, confidence intervals, and variation inflation factors for all four models. For both the numerical score and the average cutoff methods ACT Score was found to be a statistically significant predictor of Pass status ($z = 9.85$, $p < .001$ and $z = 7.65$, $p < .001$). In the latter method the odds ratio shows that a student with an above average ACT is over 3 times more likely to achieve a passing grade than students with a below average score. Both numerical score and the dichotomous ACT variable were also found to be statistically significant predictors of Fail status ($z = 6.78$ $p < .001$, $z = 5.12$ $p < .001$); In Model 1.3 and Model 1.4 the co-factor Term SP found to be a significant predictor of Fail status and Gender was found to be a significant predictor of Pass status in Models 1.1 and 1.2. Also, a student who scores above average on the ACT is 3.22 times more likely to not fail than a student with a below average score. All four models had low Vif's and therefore multicollinearity is not an issue. Likewise, linearity can be assumed for models 1 and 3 as the examination of the interaction between each continuous numerical predictor and the log of itself showed no significance. Models 2 and 4 did not have any continuous numerical predictors so linearity was not an issue.

Table. 2 Model 1.1: ACT Score as a Predictor of Pass Status

Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
ACT Score	0.22	9.85	< 2E-16	1.24	1.19	1.30	1.00

Gender (Male)	-0.47	-3.21	1.32E-03	0.62	0.47	0.83	1.00
Intercept	-2.81	-6.36	2.51E-13	0.06	0.02	0.14	N/A

Table 3. Model 1.2: Dichotomous ACT Score as a Predictor of Pass Status

Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
ACT (Above Average)	1.24	7.65	2.02E-14	3.46	2.53	4.79	1.00
Gender (Male)	-0.49	-3.34	8.22E-04	0.62	0.46	0.82	1.00
Year 17/18	0.22	1.30	0.19	1.24	0.90	1.73	1.00
Year 18/19	0.46	2.57	0.01	1.58	1.12	2.26	1.00
Intercept	1.00	7.67	1.68E-14	2.72	2.11	3.53	N/A

Table 4. Model 1.3: ACT Score as a Predictor of Fail Status

Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
ACT Score	0.20	6.78	1.18E-11	1.22	1.15	1.30	1.00
Year 17/18	0.21	0.93	0.35	1.24	0.79	1.95	1.03
Year 18/19	0.50	1.97	0.05	1.64	1.01	2.71	1.03
Term SM	0.63	0.83	0.41	1.87	0.52	11.99	1.03
Term SP	0.57	2.71	0.01	1.77	1.18	2.69	1.03

Intercept	-2.15	-3.61	3.06E-04	0.12	0.04	0.37	N/A

Table 5. Model 1.4: Dichotomous ACT Score as a predictor of Fail status

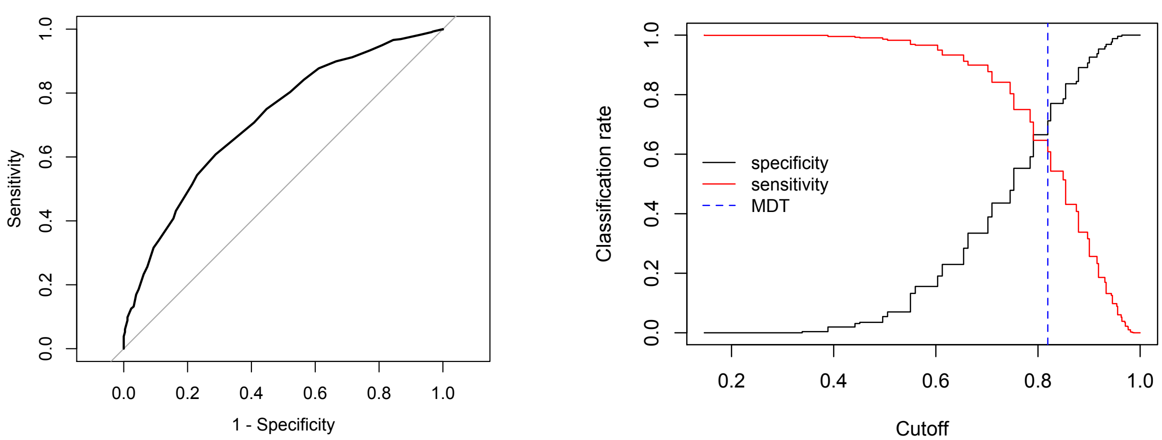
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
ACT Score	1.22	5.12	2.52E-07	3.39	2.16	5.50	1.01
Year 17/18	0.19	0.84	0.40	1.21	0.77	1.90	1.25
Year 18/19	0.46	1.86	0.06	1.59	0.98	2.60	1.25
Term SM	0.59	0.78	0.44	1.80	0.51	11.43	1.25
Term SP	0.51	2.45	0.01	1.66	1.11	2.51	1.25
Intercept	1.53	8.58	<2.0E-16	4.61	3.28	6.60	N/A

For each model two graphs are provided. The first graph is a Receiver Operating Curve (ROC) which is a plot of sensitivity vs. 1- specificity and can be used to determine the accuracy of the model by finding the area under the curve. The second graph is a plot of sensitivity and specificity against different cutoff rates used to determine the MDT or minimized distance threshold which identifies the threshold at which the distance between sensitivity and specificity is at a minimum. For Model 1.1 the area under the ROC is 0.72 which indicates a moderately accurate model. The MDT was determined to be 0.82. At this threshold the values of sensitivity and specificity were 0.647 and 0.665 respectively. Model 1.2 was found to have a slightly above average accuracy with an area under the ROC curve of 0.68. The cutoffs graph showed that the

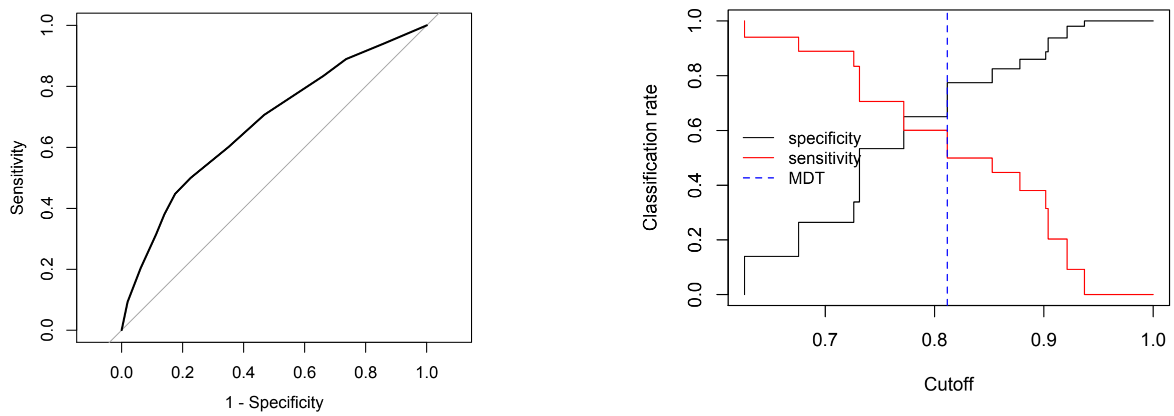
MDT was found at a threshold of 0.81 with values of sensitivity and specificity of 0.601 and 0.650.

Graph 3 shows that the area under the ROC curve for Model 1.3 is 0.72 indicating a moderately accurate model. The MDT value was 0.90 with 0.675 and 0.675 being the respective sensitivity and specificity values. Model 1.4 can be classified as having above average accuracy with a ROC area of 0.68 The second plot shows that the distance between sensitivity and specificity (0.606 and 0.667) was minimized using the threshold of 0.89. These graphs show that the models that used numeric ACT score were slightly more accurate at case classification than the models that used the dichotomous ACT score.

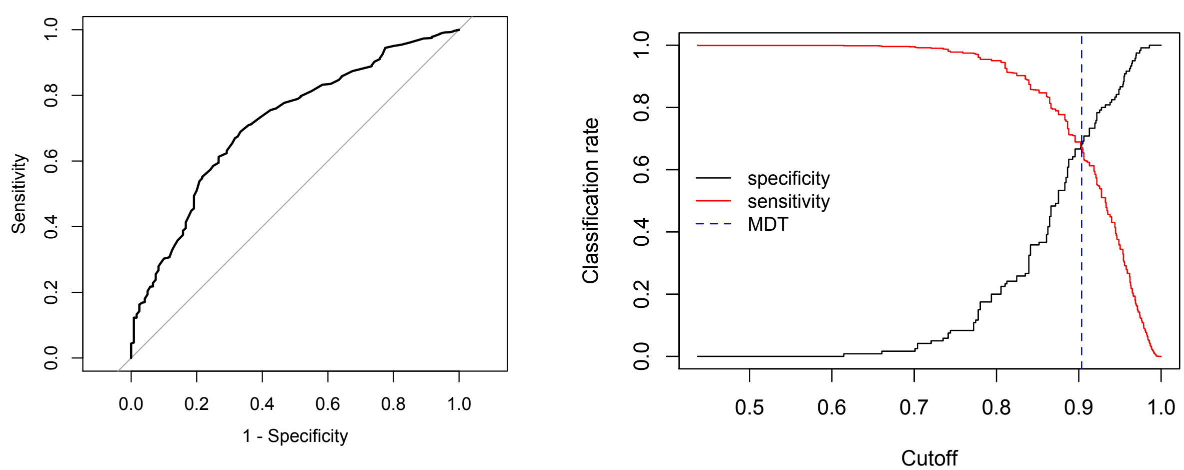
Graph 1. Model 1.1: ACT Score as a Predictor of Pass Status, ROC Curve and MDT Cut points



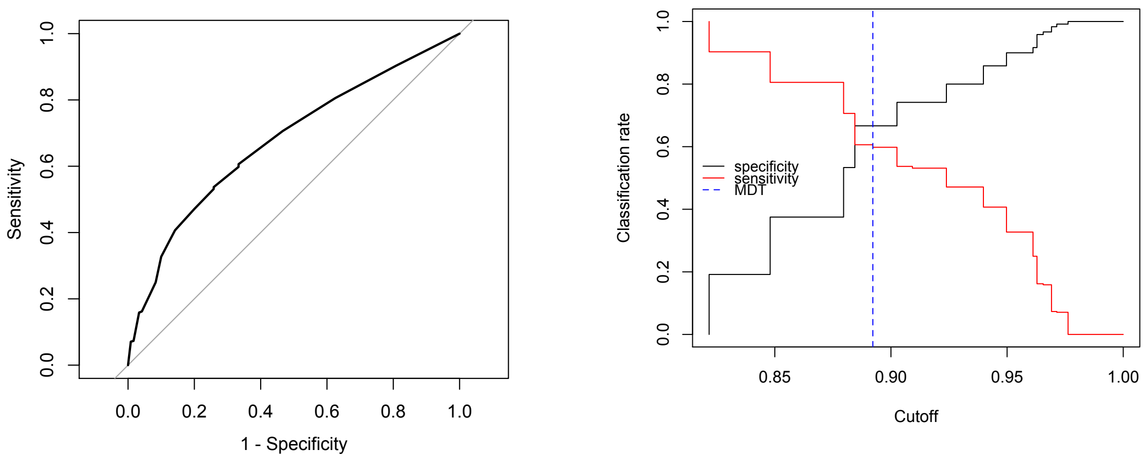
Graph 2. Model 1.2: Dichotomous ACT Score as a Predictor of Pass Status, ROC Curve and MDT Cut points



Graph 3. Model 1.3: ACT Score as a Predictor of Fail Status, ROC Curve and MDT Cut points



Graph 4. Model 1.4: Dichotomous ACT Score as a predictor of Fail status, ROC Curve and MDT Cut points



<u>Research Question #2</u>

This question was also answered in two parts. Again, both methods involved a logistic regression in two parts, one part using Pass status as the dependent variable and the other using Fail status as the dependent variable. In this analysis students were separated into two groups, one group consisting of students enrolled in College Credit Plus (CCP), the other consisting of tradition students. For the analysis there were 1349 participants; 347 enrolled in CCP, 1002 not enrolled in CCP. Table 6 shows the breakdown of enrolled students by gender.

Table 6. College Credit Plus Students by Gender

	Traditional	CCP
Female	639	211
Male	363	136
Total	1002	347

Also, there is a statistically significant difference in both mean ACT score and mean age for students enrolled din CCP and those not enrolled. The ACT means were 20.87(3.90) for traditional students and 22.54(3.46) for CCP students ($t(673.78) = -7.51$, $p < .001$). The average age of CCP students was 18.49(1.09) compared to 21.58(3.91) for traditional students ($t(1311.00) = 22.59$, $p < .001$)

A basic logistic regression model was created that just examined the relationship between Pass status and CCP status. The model showed that there was a statistically significant relationship between CCP status and whether or not a student passed or failed ($z = 6.14$, $p < .001$). A full model was created and a backwards step analysis was used to determine the most appropriate set of factors. Model 2.1 used 4 predictors: CCP status, Gender, Age, ACT Score, in the analysis of the dichotomous Pass variable. This model was found to be statistically significant when compared to the constant only model ($\chi^2(4) = 157.06$, $p < .001$). This implies that this particular set of predictors can reliably predict the students who achieved a passing status than those who do not. Using a threshold of 0.5, the percentage of accurately classified cases was 80.87 % with sensitivity and specificity of 0.978 and 0.089 respectively.

When examining the relationship between Fail status and CCP status a logistic regression model showed a statistically significant relationship ($z = 4.38$, $p < .001$). A full model was created and a backwards step analysis determined the most affective predictors. The model, Model 2.2, used the predictors: CCP status, Age, ACT Score, and Enrollment Year. This model was found to be statistically significant against the constant only model ($\chi^2(5) = 74.35$, $p < .001$). This shows that these factors can reliably predict the students who achieved a failing grade. With a threshold of 0.5, a high number of cases were accurately classified (91.10%), however the sensitivity and specificity were 1.000 and 0.000 respectively.

Tables 7 and 8 show the coefficients, test statistics, p-values, odds ratios, confidence intervals, and variation inflation factors for both models. For Model 2.1 the p-values indicate that while all predictors are statistically significant at the 0.1 level, CCP status ($z = 5.11$, $p < .001$) and Exam score ($z = 9.05$, $p < .001$) proved to be the most statistically significant with a student enrolled in CCP being 5 times more likely to achieve a passing score than a traditional student. For Model 2.2 again CCP status ($z = 3.64$, $p < .001$) and Exam Score ($z = 6.17$, $p < .001$) were statistically significant. However, in the Fail status model no other factors were significant predictors. Also, CCP students were almost 4 times more likely to not fail then traditional students. The Vif's were all low which indicates multicollinearity between predictors is not an issue in both models. For Model 2.2 linearity can be assumed as there was not a significance when the predictors were tested against the log of themselves. In Model 2.1 the assumption of linearity was violated by the variable Age as the test between Age and the log of Age showed a significant relationship ($z = -2.59$, $p < .01$). As a result, Age was removed from the model and Table 9 shows the updated results.

Table 7. Model 2.1: CCP status as a predictor of Pass status

Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
CCP (Enrolled)	1.20	5.11	3.32E-07	3.32	2.13	5.36	1.09
Gender (Male)	-0.50	-3.31	9.19E-04	0.61	0.45	0.82	1.00
Age	0.04	1.99	0.05	1.04	1.00	1.09	1.12
Score	0.20	9.05	< 2E-16	1.23	1.18	1.28	1.06
Intercept	-3.63	-5.24	1.64E-07	0.03	0.01	0.10	N/A

Table 8. Model 2.2: CCP status as a predictor of Fail status

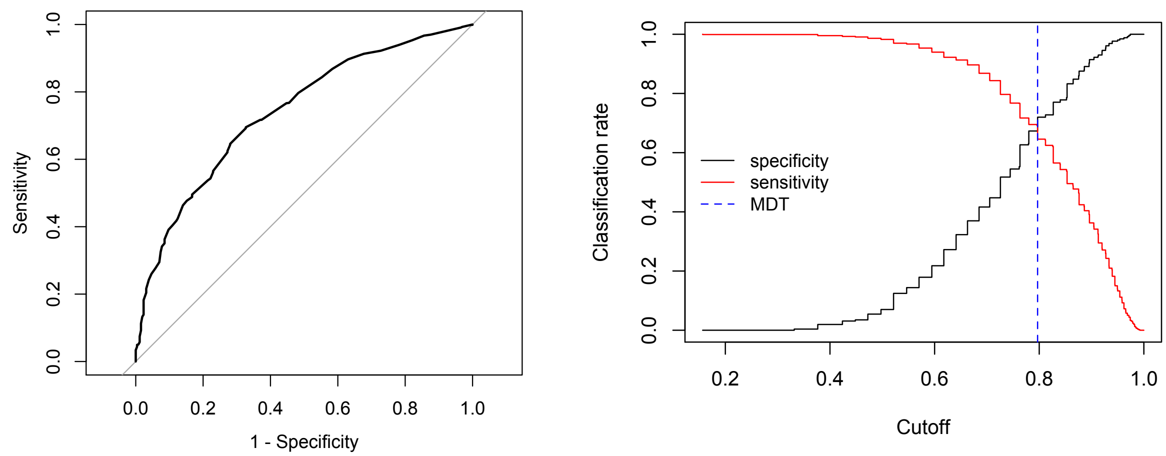
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
CCP (Enrolled)	1.33	3.64	2.72E-04	3.79	1.95	8.31	1.06
Age	0.03	1.25	0.21	1.03	0.98	1.10	1.13
Score	0.18	6.17	6.98E-10	1.20	1.13	1.28	1.06
Year 17/18	0.15	0.67	0.51	1.17	0.74	1.84	1.04
Year 18/19	0.44	1.73	0.08	1.55	0.95	2.57	1.04
Intercept	-2.48	-2.69	0.01	0.08	0.01	0.49	N/A

Table 9. Model 2.1.1: CCP status as a predictor of Pass status (Age removed)

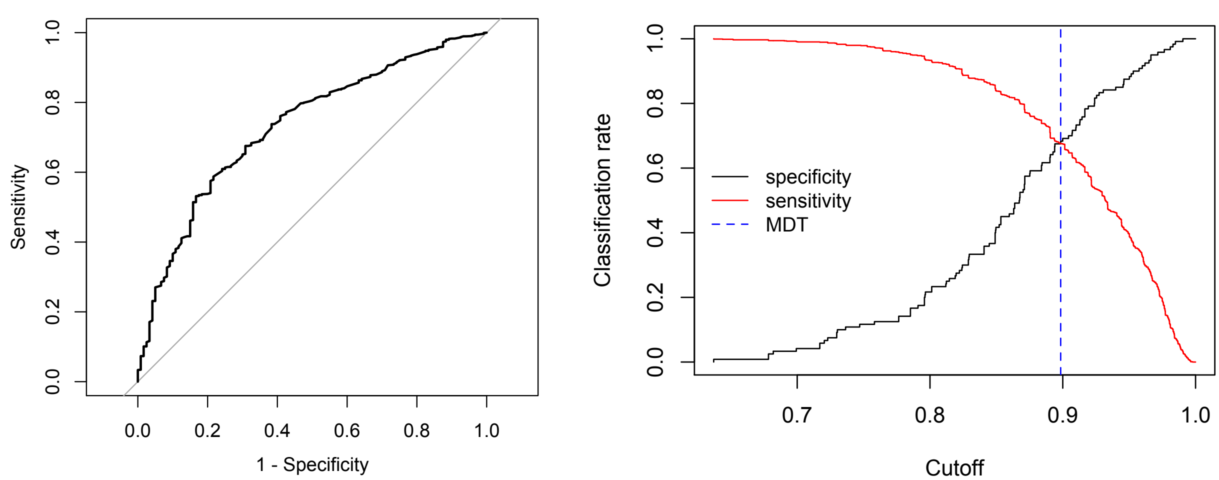
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
CCP	1.08	4.74	2.150E-06	2.93	1.91	4.67	1.02
Gender (Male)	-0.49	-3.30	9.57E-04	0.61	0.46	0.82	1.00
Score	0.20	8.86	<2E-16	1.22	1.17	1.27	1.02
Intercept	-2.57	-5.81	6.45E-09	0.08	0.03	0.18	N/A

The ROCs and MDT cut points plots for both models are shown in Graphs 5 and 6. Both models had areas under the ROC that indicated a moderate to high level of classification accuracy. (0.74 for Model 2.1.1 and 0.73 for the Fail status model). For the Pass status model (Model 2.1.1), the cut points plot found that the minimized distance threshold was 0.80. At that threshold the values of sensitivity and specificity were 0.692 and 0.673 respectively. The Fail status model had similar sensitivity and specificity values (0.677 and 0.675) which were obtained using the MDT of 0.90.

Graph 5. Model 2.1.1: CCP status as a predictor of Pass status (Age removed), ROC Curve and MDT Cut points



Graph 6. Model 2.2: CCP status as a predictor of Fail status, ROC Curve and MDT Cut points



Research Question #3

Once again, research question #3 was answered in two parts with both Pass status and Fail status as the dependent variables. For this analysis students were placed into two groups based upon their declared major. These groups were STEM majors and Non-STEM majors, as determined by ACT.org (STEM, 2019). A complete list of the majors broken down by group is provided in Appendix B. For this analysis 478 of the 1349 students did not have a declared major in the form of: undecided, non-degree, or CCP students. Based on the non-declared major they were not able to be classified into STEM or Non-STEM and were therefore excluded from this analysis. A visualization of STEM status by gender is provided in Table 10.

Table 10. STEM Students by Gender

	STEM	Non-STEM
Female	231	314
Male	111	215
Total	342	529

When excluding the students with a non-declared major the average age rose to 21.75(4.07) and was statistically significant across STEM status ($t = -4.13$, $p < .001$) with the mean age of Non-STEM students 21.26(3.46) and 22.50(4.77) for STEM students. While the mean age rose the mean ACT, score fell overall to 20.62(3.93). Mean ACT score for STEM students was 21.70 with a standard deviation of 3.78 compared to 19.92 with a 3.86 standard deviation for Non-STEM students showing a significant difference across STEM status. ($t(570.15) = -6.75$, $p < .001$)

A logistic regression analysis was conducted on Pass status and student major. The analysis found that there was not a statistically significant relationship between any major and Pass status, with all p values greater than 0.9. However, when classified into STEM and Non-STEM majors a significant relationship did emerge. When STEM status was the only predictor the analysis found the model was reliable in predicting a student's Pass status based on whether or not they were a STEM major ($z = 8.43$, $p < .001$). A saturated model was created and a backwards step analysis was completed to find the best predictor model of Pass Status. The step analysis revealed a model with 6 predictors: STEM status, Gender, Age, ACT Score, and Enrollment Year. The resulting Model 3.1 was found to be statistically significant when compared to the constant only model ($\chi^2(6) = 107.13$, $p < .001$). These predictors were able to reliably distinguish between students who Passed the Stats class and those who did not. The model accurately classified students 76.23% of the time with a threshold of 0.5. This resulted in a sensitivity of 0.925 and a specificity of 0.161.

A logistic Regression was also used to examine the relationship between Fail status and STEM status. A backwards analysis of the full model was conducted to obtain a model with only 3 predictors. Model 3.2 used STEM status, Gender, and ACT score to predict the outcome of the dichotomous Fail status variable. This model was statistically significant when compared to the null model ($\chi^2(3) = 40.76$, $p < .001$). Classification success was high with 770 of 871 cases accurately classified (88.40%) using a threshold of 0.5, however sensitivity and specificity values were 0.999 and 0 respectively.

Tables 11 and 12 show the coefficients, test statistics, p-values, odds ratios, confidence intervals, and variation inflation factors for both models. In Model 3.1 STEM status, Gender, Year 18/19, and Exam score are all significant at the 0.05 level. Age and Year 17/18 are not statistically significant as the different levels of each predictor are equally likely as evidenced by the inclusion of 1 in their 95% CI. The analysis also shows that a student in a STEM major is about 2 times more likely to achieve a Pass status than a student in a Non-STEM major. In Model 3.2 STEM status was not found to be statistically significant (z = 1.00, p = 0.32). So, while this model was significant in predicting Fail status, students in STEM majors were not found to be any more or less likely to fail then Non-Stem students. The test of interaction between each continuous numerical predictor and the log of itself showed no significance so linearity can be assumed for both models. Again, multicollinearity was not an issue as shown by the low Vif values.

Table 11. Model 3.1: STEM status as a predictor of Pass status

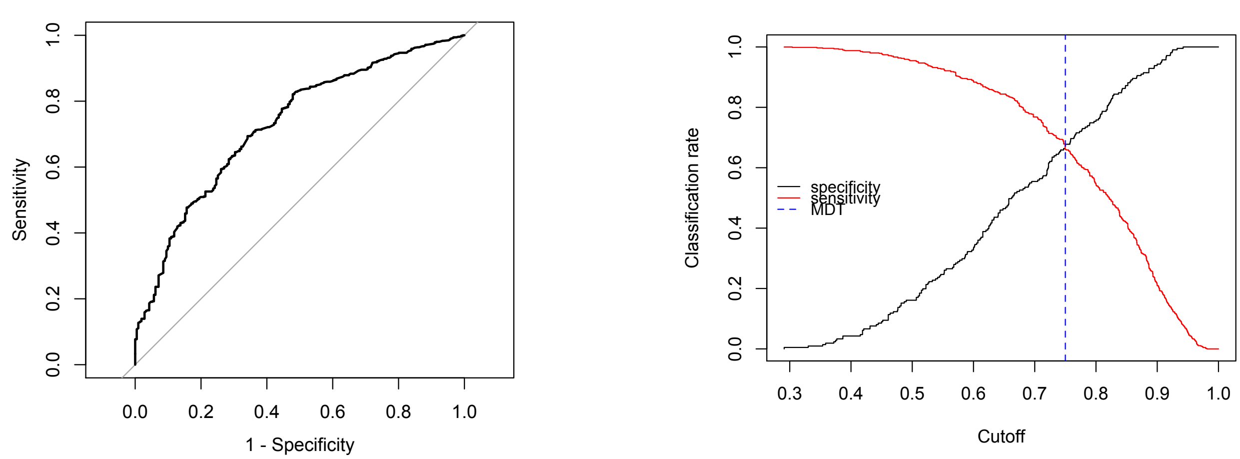
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
STEM	0.73	3.63	2.31E-04	2.08	1.41	3.08	1.09
Gender (Male)	-0.38	-2.20	0.03	0.68	0.49	0.96	1.01
Age	0.04	1.84	0.07	1.04	1.00	1.09	1.11
Score	0.18	7.07	1.47E-12	1.20	1.14	1.27	1.08
Year 17/18	0.16	0.81	0.42	1.18	0.79	1.75	1.04
Year 18/19	0.53	2.48	0.01	1.69	1.12	2.58	1.04
Intercept	-3.72	-4.70	2.65E-06	0.02	4.94E-03	0.11	N/A

Table 12. Model 3.2: STEM status as a predictor of Fail status

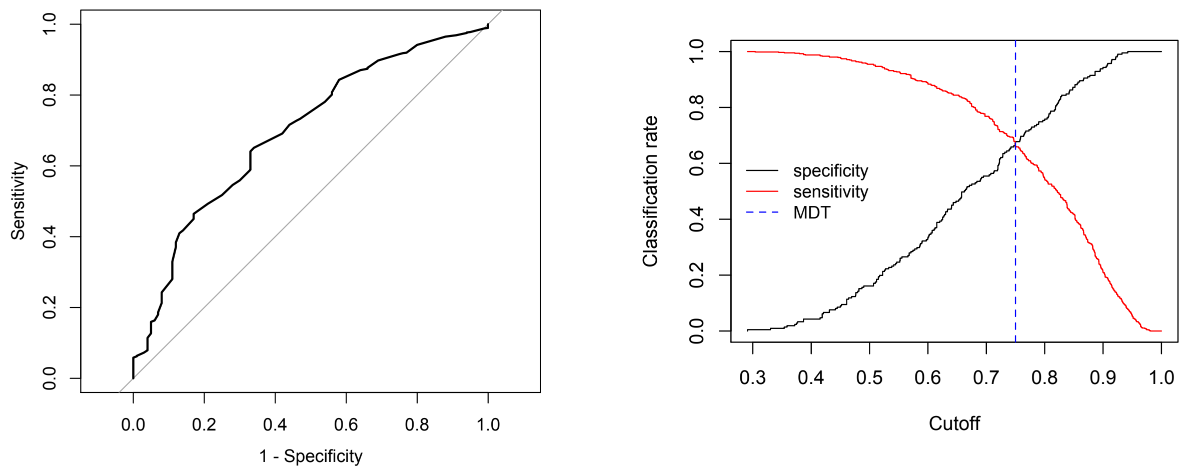
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
STEM	0.25	1.00	0.32	1.28	0.80	2.10	1.06
Gender (Male)	-0.21	-0.98	0.33	0.80	0.52	1.25	1.01
Score	0.18	5.41	6.28E-08	1.20	1.12	1.28	1.05
Intercept	-1.46	-2.33	0.02	0.23	0.07	0.78	N/A

Graphs 7 and 8 show the ROC and MDT cut points plot for both the Pass status and Fail status models. For the Pass status model, the area under the ROC was 0.73 indicating a relatively accurate classification. The minimized distance threshold came at the value of 0.75 with a sensitivity of 0.662 and a specificity of 0.673. The Fail model had a similar classification accuracy with an area of 0.69 under the ROC. The sensitivity and specificity values of 0.651 and 0.660 were obtained using the MDT of 0.88.

Graph 7. Model 3.1: STEM status as a predictor of Pass status, ROC Curve and MDT Cut points



Graph 8. Model 3.2: STEM status as a predictor of Fail status, ROC Curve and MDT Cut points



<u>Research Question #4</u>

This research question was also answered using both Pass status and Fail status as the dependent variables. Two different approaches were taken to answering this question. The first approach was to perform logistic regression techniques on the dichotomous variable Scholarship which was an indicator of whether or not a student had received a merit-based scholarship or not. The second method grouped students into those who had received financial aid they had to pay back (Subsidized or unsubsidized loans) or aid they did not have to pay back (Pell Grant or merit-based scholarships). This analysis utilized 1359 students. Of these students 1011 received loans, 816 received a Pell Grant, and 533 received a merit-based scholarship; 634 students received both a Pell Grant and had loans, 261 received a scholarship and had loans, 230 students received a scholarship and a Pell Grant, and 114 students received all three.

In the first approach a logistic regression analysis found that a there was not a significant relationship between students who received scholarships and Pass status ($z = -0.33$, $p = 0.74$) or Fail status ($z = -0.28$, $p = 0.78$). This indicates that a student who received a merit-based scholarship was no more likely to pass or not fail than any other student. A backward step analysis of this model proved to be ineffective as the analysis removed the primary predictor Scholarship from the final model.

The second approach used logistic regression techniques to determine if there was as statistically significant relationship between Pass or Fail status and whether a student received loans or not. For Pass status a step analysis was performed on the full set of predictors to reveal Model 4.1 with the predictors: Loan Status, Gender, and ACT Score. This model was statistically significant when compared to the null model ($\chi^2(3) = 120.26$, $p < .001$). The percentage of accurately classified cases was 82.36% (1111 out of 1349) with a sensitivity of 0.988 and a specificity of 0.047.

The Fail status model was also obtained using a backwards step analysis. This model included the predictors: Loan Status, ACT Score, Enrollment Year, and Enrollment Term. When compared against the constant only model this model, Model 4.2, was shown to be statistically significant ($\chi^2(6) = 65.02$, $p < .001$). While 91.03% of cases were accurately classified, this model accurately classified a high number of true positives, but there were a large number of false positives shown by sensitivity and specificity values of 1.000 and 0.000 respectively.

Tables 13 and 14 show the coefficients, test statistics, p-values, odds ratios, confidence intervals, and variation inflation factors for both models. In Model 4.1 Loan status, along with gender and ACT score, was found to be a significant predictor of Pass status ($z = 1.87$, $p < .06$) at the 0.1 level of significance, with a student who has loans being 1.5 times more likely to pass then a student with no loans. Model 4.2 shows that while Loan is a significant predictor of Pass status it is not a significant predictor of Fail status ($z = 0.60$, $p = 0.55$). The statistical significance in this model comes from ACT score (z = 6.79, p < .001). Linearity can be assumed for both models as the test of interaction between the continuous numeric predictors and their logs showed no significant results. Multicollinearity is also not an issue in either model as all factors have low Vif's.

Table 13. Model 4.1: Loan Status as a predictor of Pass status

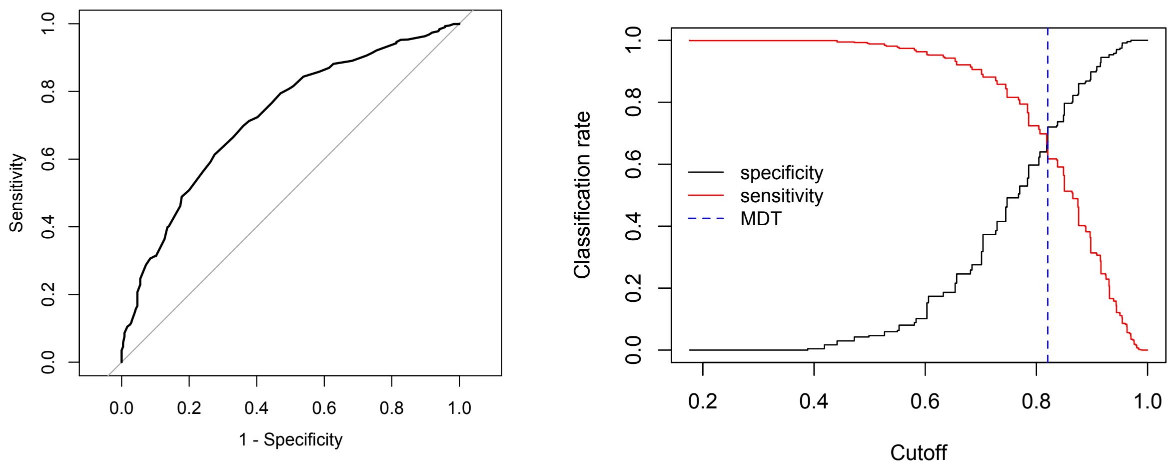
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
Loan	0.31	1.87	0.06	1.5	0.98	1.88	1.00
Gender (Male)	-0.45	-2.94	3.30E-03	0.67	0.47	0.86	1.00
Score	0.22	9.53	<2E-16	1.22	1.19	1.30	1.00
Intercept	-2.93	-6.19	5.90E-10	0.052	0.02	0.13	N/A

Table 14. Model 4.2: Loan Status as a predictor of Fail status

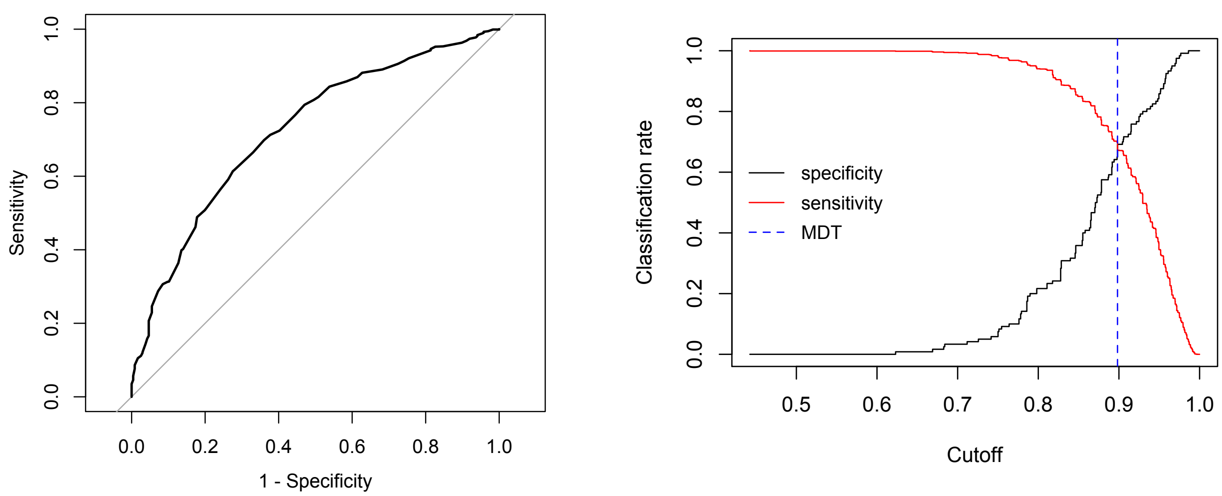
Variable	β	Test Statistic	P -value	Odds Ratio	95% CI Lower	95% CI Upper	Vif
Loan	0.13	0.60	0.55	1.14	0.73	1.74	1.02
Score	0.20	6.79	1.14E-11	1.22	1.15	1.30	1.00
Year 17/18	0.21	0.90	0.37	1.23	0.78	1.94	1.05
Year 18/19	0.48	1.88	0.06	1.61	0.99	2.76	1.05
Term SM	0.63	0.83	0.41	1.87	0.52	11.99	1.04
Term SP	0.55	2.64	0.01	1.75	1.16	2.66	1.04
Intercept	-2.25	-3.64	2.73E-04	0.11	0.03	0.35	N/A

Graphs 9 and 10 show the ROC and MDT cut points plot for both the Pass status and Fail status models. Model 4.1 has an accurate classification with an area under the ROC curve of 0.72. The minimized distance threshold (0.82) provided sensitivity and specificities of 0.665 and 0.669. Model 4.2 had similar results with a sensitivity of 0.680 and a specificity of 0.675 coming at a threshold of 0.90 with an area of 0.72 under the curve.

Graph 9. Model 4.1: Loan status as a predictor of Pass status, ROC Curve and MDT Cut points



Graph 10. Model 4.2: Loan status as a predictor of Fail status, ROC Curve and MDT Cut points



Chapter Summary

This study was conducted to determine which, if any, factors were useful predictors of student success in college. Through analysis the study determined that several factors, individually and in conjunction with others, were able to be used to successfully determine which students either passed or did not fail a specified math course. Of the four research questions, two had comparable results between the Pass status and Fail status models (RQ #1 and RQ #2) and two had conflicting results (RQ #3 and RQ #4) In the Model 3.1 STEM status was statistically significant in the prediction of Pass status ($z = 3.63$, $p < .001$), but in Model 3.2 STEM status was not found to be statistically significant when used as a predictor of Fail status ($z = 1.00$, $p = 0.32$). Similarly, in Model 4.1 Pass status had a significant relationship with Loan status at the 0.1 level of significance ($z = 1.87$, $p < 0.1$) while Fail status did not have a significant relationship with Loan status in Model 4.2 ($z = 0.60$, $p = 0.55$). This indicates that while significant relationships exist between predictors and Fail status, passing seems to be a better indicator of success than not failing. Due to this finding, success will hereafter be defined just as passing rather than both passing and not failing.

The factors that were successful predictors of success were: ACT Score, Age, Gender, STEM status, CCP status and Loan status. The most effective of these was ACT score as it was a significant predictor in every single model run in the analyses. The original hypothesis was that the higher a student's ACT score the more likely they would be to achieve success in a college class. These results of this study are highly in support of that hypothesis.

This study also showed that STEM status and CCP status were significant predictors of success as students enrolled in CCP and students that have a declared STEM major are much more likely to succeed then their counterparts. While these results are consistent with expectations it is important to note that there was a significant difference in both age and mean ACT score across both STEM and CCP status. Age is most likely not a confounding factor as younger students were found to more likely to succeed in the CCP status model but older students were more likely to succeed in the STEM status model. ACT score is more likely a confounding factor as students with higher ACT scores were more likely to succeed in both models. However, this could be explained by examining how likely it is for students with higher ACT scores to enroll in CCP or have a declared STEM major.

In the analysis of Loan status, it was found that Loan was a significant predictor of Pass status, this means that students who are responsible for paying back the money they used for college were more likely to succeed than those who received aid via a scholarship or Pell Grant. It is possible this illustrates how non-cognitive factors such as motivation may play a role in success. Along the same lines the same analysis also revealed that students who received merit-based scholarships were no more likely to succeed than those who did not. This is the opposite of the expectation that merit based award winners would be more likely to succeed. It is also interesting to note that gender was a significant factor in many models, every time with females being anywhere from 1.32 to 1.54 more likely to succeed than males.

The purpose of this chapter was to examine the results of the study and determine if any factors were able to predict student success. Through analysis many factors were determined to be significant in determining student success, with ACT score, STEM status, and CCP status being the most prominent. While these factors are significant, it cannot be determined with certainty that these factors were the cause of the success. As the literature review showed there are many other factors that could influence success that this study did not account for. So, while it is the conclusion of this study that ACT score, STEM status, and CCP status are significant in determining success, readers should take these results with caution and be aware of other influential factors.

CHAPTER 5: SUMMARY

The purpose of this study was to determine if there factors that a successful in predicting student success in college. A great deal of research has been conducted on this subject and most results find that there are many academic, personal, mental, emotional, and environmental factors that can be used to predict student success. While this study was not completed in the manner that it was originally intended, significant results were still obtained that provided necessary insight to the topic of student success. If this study were repeated it could be done with the original research questions in mind, while looking specifically at exam component scores.

This study specifically analyzed data obtained from students enrolled in a statistics class at Shawnee State University over the last four years. This data showed that ACT score is largely important in predicting student success, consistent with numerous other studies (Adams, 2018; Allen & Sconing, 2005; Belfield & Crosta, 2012; Bettiger, et al. 2013; Curabay, 2016; Focareto, 2006; Geiser & Santelicies, 2007; Gregory, 2018; Noble & Sawyer, 2002; Noble & Sawyer, 2004; Sanchez, 2013; Sun, 2017). This study also showed that a student's enrollment in CCP or his/her declaration of a STEM major can also be used to significantly predict student success. While these factors were shown to be significant predictors of success through this study it is important to realize that success is an abstract concept and a student's ability to achieve that success can be influenced by a limitless number of factors. While this study contributed to the large collection of research that attempts to answer this question, the vastness of this topic can never truly be conceptualized.

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APPENDIX A

This page contains the approval for this study from the Shawnee State University IRB, November 30,

I

IRB

Fri 11/30/2018 10:23 AM

Zachary Shepherd

Zachary, As Chair of the IRB committee I approve the exempt status of your reseach titled, "ACT score and freshman year college success. A predictive study." Please remember to report any unusual incident and final study reports found on the IRB website.

Edward Kehres, PhD, OTR/L
Chair, IRB Committee
Shawnee State University

APPENDIX B

This page contains the breakdown of student majors into STEM and Non-STEM majors along with the number of students participating in the study who had declared that particular major. STEM and Non-STEM classification obtained via Act.org (STEM, 2019)

Non-STEM Degrees	**# of Students**	**STEM Degrees**	**# of Students**
Accounting	2	Athletic Training	5
Arts/Humanities	1	Biology	60
Business Management	1	Chemistry	11
Early Childhood/Special Ed.	2	Computer Engineering Technology	3
Educational Studies	1	Dental Hygiene	9
English Humanities	12	Digital Simulation/Game	6
Fine Arts	11	Electromechanical Engineering	4
General Studies	233	Environmental Engineering	2
Heath Care Administration	4	Health Science	42
History	5	Information Systems Management	2
Individual Studies	3	Mathematical Sciences	4
Internal Relations	6	Medical Laboratory	12
Legal Assisting	1	Natural Science	132
Management	5	Nursing (LPN)	20
Marketing	2	Nursing (RN)	12
Middle Childhood Education	8	Physical Therapy Assistant	15
Occupational Therapy	24	Respiratory Therapy	3
Occupational Therapy Assistant	30		
Philosophy and Religion	3		
Political Science	20	**Excluded Degree Classifications**	
Psychology	79	College Credit Plus	347
Social Science	1	Non-Degree	5
Social Sciences	11	Undecided	125
Sociology	23		
Sport Studies	42		

BIBLIOGRAPHY

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Master of Science Mathematical Sciences

Thesis: ACT SCORE AND COLLEGE SUCCESS: A PREDICTIVE STUDY

Major Field: Mathematical Sciences

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Personal Data: Zachary Shepherd lives with his wife, Dr. Kenna Shepherd, in Indianapolis, IN with their dog Levi. Zak grew up in Columbus, OH then moved to Cincinnati, OH were he completed his undergrad work. After undergrad Zak moved back to Columbus where he and Kenna were married. They recently moved to Indianapolis so that Zak could complete a PhD program in Biostatistics at Indianapolis University Purdue University of Indianapolis. In his free time Zak enjoys reading books, going to the movies, and taking walks with his family. After the completion of his PhD program Zak hopes to work as a professor of statistics or work for a pharmaceutical company.

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8/5/2019

ADVISER'S APPROVAL: Dr. Douglas Darbro, Graduate Director