Final Report and Proposal

from the

Admissions Standards Taskforce

Contents:

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The Admissions Standards Taskforce has considered the question of whether or not Shawnee State should impose admissions standards on entering students, and if so, how they should be implemented.

We make the following proposal:

Eventually, in order to gain unconditional admission to Shawnee State University as a degree-seeking student, freshmen applicants must meet two of the following three criteria:

    I. Achieve a minimum high school grade point average
        a. Task force members' preferences for the minimum GPA range from 2.0 to 2.5 on a 4.0 scale.
        b. For adult students (age 21+) who are not required to present standardized test results, they will be required to take the SSU placement test and place at the "college level" and meet one of the two other criteria.
    II. Achieve a minimum ACT composite test score
        a. Task force members' preferences range from 16-18, with a corresponding minimum SAT of 770 (Critical Reading + Math)
    III. Achieve a high school class rank in the upper 2/3 of their class
        a. For students who attend high schools who do not provide a class ranking, they must meet both of the other two criteria.

There is now a Board of Trustees policy exempting students over the age of 21 from submitting ACT scores. If admissions standards are adopted, it may be appropriate to change this and make the policy consistent for all applicants.

Rationale

In Fall 2007, SSU enrolled 837 new degree seeking freshmen students. Of those, approximately 119 did not meet two of the three admission criteria. 74 students did not present an ACT or SAT result and 49 had no high school GPA and/or rank in class data on file.

68/119 (57.1%) achieved a GPA < 1.0 during the Fall 2007 semester. 67/119 (56.3%) were enrolled in the SP 2008 semester. 31/119 (26.1%) were enrolled in the Fall 2008 semester. 18/119 (15.1%) were enrolled in the SP 2009 semester. 22/119 (18.5%) were enrolled in the FA 2009 semester. 14/119 (11.8%) were enrolled in the Spring 2010 semester. 13/119 (10.9%) are enrolled in Fall 2010.

In Fall 2008, SSU enrolled 1103 new degree seeking freshmen students. Of those, approximately 148 did not meet two of the three admission criteria. 83 students did not present an ACT or SAT result and 53 had no high school GPA and/or rank in class data on file.

73/148 (49.3%) achieved a GPA < 1.0 during the fall 2008 semester. 82/148 (55.4%) were enrolled in the SP 2009 semester. Only 48/148 (32.4%) were enrolled in the FA 2009 semester. 32/148 21.6% were enrolled in the SP 2010 semester. 30/148 (20.3%) are enrolled in Fall 2010.

In Fall 2009, SSU enrolled 1130 new degree seeking freshmen students. Of those, approximately 154 did not meet two of the three admission criteria. 94 students did not present an ACT or SAT result and 74 students had no high school GPA and/or rank information entered. 53 had neither a test result nor GPA/rank data on file.

90/154 (58.4%) achieved a GPA < 1.0 during the FA 2009 semester. 92/154 (59.7%) were enrolled in classes during the SP 2010 semester. 49/154 (31.8%) are enrolled in Fall 2010.

In Fall 2010, approximately 150 new students did not meet two of the three criteria.

Note that these numbers are "approximate" due to possible data entry omission and/or other circumstances. For example, if a high school does not list a student's rank in class or GPA on the transcript, the Office of Admission does not "chase" that information. Documentation of graduation is satisfactory for admission.

It is important for all to understand that there will be both short and long term impacts on enrollment. If these criteria had been in place since 2007, it is likely that our fall 2010 enrollment would have been closer to 4300 rather than 4561.

Phase-in of Standards

Because this proposal represents a significant move from the Open Admission philosophy that Shawnee State University has had since its inception, we recommend that this program be "phased in." About 18 months (from now) will be needed to give fair notice to potential applicants before the change begins. The phase-in should take place over the following two years, with the change completed four years from now, at the latest.

- In the first year of implementation, applicants must meet one of the three admission criteria, and all freshmen applicants under the age of 21 (as of the first day of the term) will be required to submit ACT or SAT results.

- In the second year of implementation, applicants must meet two of the three admission criteria, and all freshmen applicants under the age of 21 (as of the first day of the term) will be required to submit ACT or SAT results.

Procedure for Adoption

To make the change to selective admissions, the administration should submit a proposal to EPCC and the Faculty Senate for faculty approval first, followed by the Board of Trustees.

Setting or changing the specific admission criteria should be initiated by a committee that includes representatives from the faculty, Office of Admissions, and the administration, with student observers. The committee's standards would be approved by the Provost and then submitted to EPCC for faculty approval.

Cost/Benefit and Finding the Proper Admissions Cut-offs

Any admissions standards will result in smaller entering classes at first. Ultimately, the admissions criteria are not aimed so much at specific scores as they are intended to eliminate students with a low chance of succeeding. A study on SSU graduation rates (Bogard 2011; Appendices A & B) produced models to predict a student's probability of graduating within six years, given ACT scores and high school GPA. The goal is to find standards which eliminate the largest number of potential non-graduates (blue bars in the model results) while eliminating the fewest potential graduates (green bars).

While the task force recommends the standards above as a general guide, the specific standards should come from a cost/benefit study that accounts for the following:

1. tuition paid by admitted students (more students leads to more tuition income),

2. payments from the state based on retention and course completion (which rewards SSU for the quality of the students admitted),

3. operating costs based on the number of students, and

4. potential loss of the special state subsidy for SSU.

We recommend that this be done by taking the proposed cut-offs, using Bogard's graduation model to predict the number of students admitted and how many will graduate on time, and applying those numbers to the cost/benefit analysis to find the effect on the university's budget. The Director of Institutional Finance would be an appropriate person to coordinate this work.

The experience of other schools (Appendix C) shows that in many cases, there was a drop-off in overall enrollment immediately upon imposing admissions standards, but that enrollment rose to the previous levels after 2-3 years.

Developmental Education and Rejected Applicants

Bogard's study on SSU graduation rates (Appendices A & B) found that taking a remedial class is the biggest predictor of a student failing to graduate from SSU within six years, and of the remedial courses, Reading (English 0097/0098) is the biggest predictor. (Note that in the models presented in Appendices A & B, ACT subscores are used instead of courses, since these scores determine placement into the remedial courses.) Shawnee State should make the elimination of remedial courses—especially Reading—a priority in designing admissions standards. This should be done, even if nothing else from this proposal is adopted.

University College or Community College?

Any admissions standards will create a group of rejected applicants, and we should consider how to deal with them. Some other schools in our situation have made agreements with neighboring community colleges to handle these students' remedial needs and allow them to reapply later. In our case, there is no nearby community college, and SSU has filled this role itself, to an extent. We see three options:

1. Handle developmental education in-house at first, using some version of the University College.

2. Try to cultivate a separate institution into a community college.

3. Decide these students aren't our problem.

Option 1 can be implemented most quickly, while 2 would be the toughest to work out immediately. One approach could be to start by changing the University College's role and eventually spinning it off into a separate institution. Another would be to work with the Scioto County Career Technical Center to change it into a community college. If developmental courses are taught at SSU, they should be taught by full-time professors, not adjuncts. Quality education is especially important for these students, because of their high failure rate. If developmental education remains as part of SSU, though, it is bound to interfere with the admissions standards. *Over the long term, we should eliminate the need for developmental education on our campus.*

As we have pointed out above, students needing developmental courses are very likely to fail out of SSU, even if they eventually pass the remedial classes. Therefore, rejected applicants who are sent elsewhere (University College or a community college) for developmental courses should not be granted automatic admission once they finish them. They should have to reapply and submit new ACT scores.

Regional Standards?

How should we deal with applications from our region—specifically those applicants from Scioto, Lawrence, Adams and Pike counties in Ohio and Greenup County in Kentucky who do not meet admission requirements? We do not believe local students should be held to lower admissions standards than the rest of the applicants. If we want to serve this region especially, the best approach might be to have the remedial program described above be designed especially for local students.

Other Points to Consider

Ethical Aspect

As things sit now, we are admitting a lot of students who are taking out student loans but will fail to graduate. This means we are saddling them with large debts, but they won't earn a degree, their job prospects aren't much improved, and they wind up in long-term debt. So there is a moral problem with admitting degree-seeking students who simply have no chance of getting a degree.

Status of Shawnee State

While we can expect enrollment to fall at first, the experience of other schools makes us believe we will recover fairly quickly. Much of this may be from the status of the school. Imposing any standards makes us a more selective university, by definition, and that should make us a more desirable one.

Right now, our two biggest advantages are in being open enrollment and low cost. Raising the status of Shawnee State will take a while, but the low-cost advantage will still help us in the meantime, especially while the economy is weak. Once the economy improves, we might need something else. We should work to improve the "college life experience" for students coming here, with more on-campus housing, and with the campus neighborhood improved and hosting the kinds of businesses that depend on college students.

Final Report
Student Retention Prediction Study
for Student Assessment Mini-Grant #2 (2010-11)

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Abstract
The aim of this project has been to create a formula that would allow Shawnee State to predict which students are likeliest to drop out of SSU in the next semester and target them with tutoring and other help. The motivation is to improve student retention, especially in the light of changes to state university financing, which now is based on graduation rates and even course completion.

The project has been able to create a formula that predicts the chance that an incoming freshman will graduate from SSU within six years. (The six-year limit is based on the standard for "on-time" graduation in the state funding formula.) This is narrowed from the original scope of a semester-by-semester formula, because the school record-keeping from six years ago was inconsistent in recording many of the variables used for this project. The results of this project have been presented to the Admissions Standards Committee and are being included in its recommendations to the university.

For this project, I had the assistance of Arthur Bogard, a senior math major. He performed the data processing and used this in his senior project (his report is attached as the Supplement). Prof. Doug Darbro (Department of Mathematics) advised on the statistical methods used.

Description of Procedures and Work
   Sample Selection
Data were obtained for students entering as freshmen in the fall of 2002, 03, and 04. This was the earliest data available under the current records system. Later classes weren't used because there is still time remaining for them to graduate "on time" (*i.e.*, within six years). Jonica Burke and Kim Patton from the Office of Institutional Research provided the data.

   Mathematical methods
The original plan was to use a *linear regression*, in which the probability of a student being retained (either for the next semester or through to graduation) would be expressed as a linear function of the input parameters. On Doug Darbro's advice, a so-called *logistic regression* was adopted instead. A linear model assumes that, for instance, a 20% change in an input parameter (say, high school GPA) will produce twice the effect of a 10% change in that parameter. But this isn't likely when we are describing *probabilities* of behavior. The logistic regression instead allows the effect of changing a

parameter to vary. It is also better suited to cases in which we're describing the probability of an outcome (in this case, the probability of graduation within six years). The mathematical details are explained in detail in the Supplement.

Final Model
The most effective and useful model (labeled "Logistic Model 1" in the Supplement) is able to correctly identify those students who are least likely to graduate from SSU within six years, but it isn't as good at identifying those who *are* likely to graduate within the timeframe. The only parameters it uses are high school GPA, ACT Composite score, and ACT Reading sub-score. The Supplement provides the formula for the model; an Excel spreadsheet for applying it is also attached.

The plot below is a histogram of students, broken down into those who did not graduate from SSU (blue), those who graduated but not in time (red), and those who graduated from SSU within six years (yellow-green).

Predicted Probability of Success
Figure 3
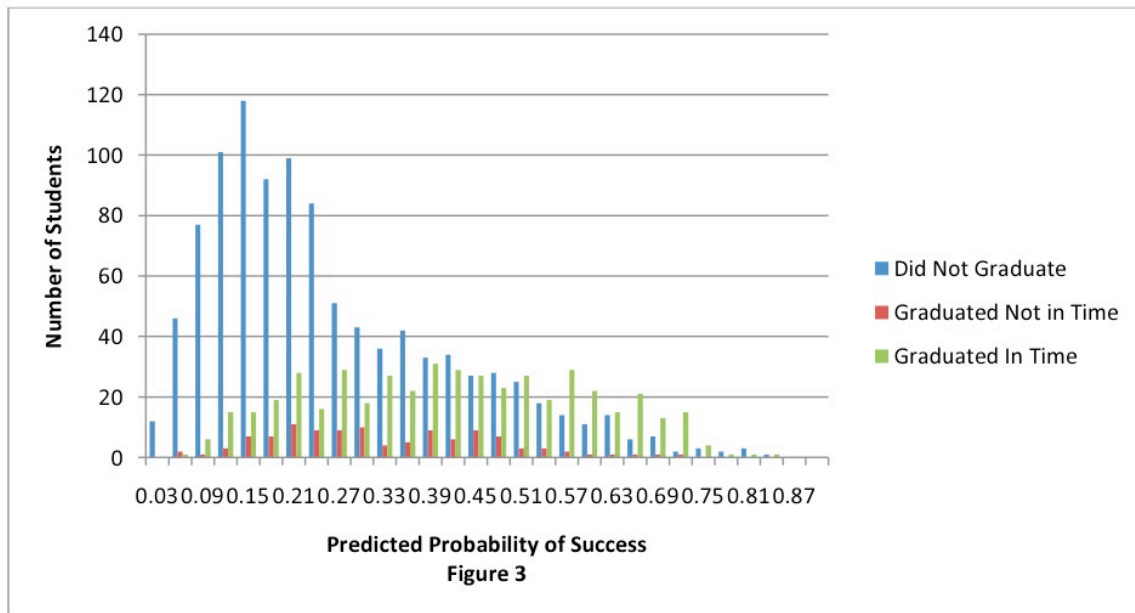
The horizontal axis is the model's prediction for each student's chance (probabilities from 0.0 to 1.0) of graduating on time. The vertical axis is the number of students predicted to have that chance, and the actual results (whether they graduated or not) are shown by the color coding.

What we get from this figure is that students who are *predicted* not to graduate (those on the left side of the plot) do not *actually* graduate. (The blue histogram peaks here.) On the other hand, those who are *predicted* to graduate (those on the right side of the plot) are *actually* pretty evenly split between graduating and not graduating. (The yellow-green histogram and the blue histogram are about equally high here.) At the far right-hand side, we do see graduates exceed non-graduates, but the contrast is not nearly as well defined as for the predicted failures on the left.

Interpretation of Results
What we should take from this is that if a student has a very low predicted probability to graduate, then this is probably what will happen, absent some intervention and assistance. On the other hand, if a student has a high predicted probability of graduating, we can't consider the prediction reliable. If we base our in-school intervention on this model, we will correctly identify many students who will otherwise fail to graduate, but we will miss a number of future drop-outs who are incorrectly predicted to do well. Still, this model will allow us to target the students most in need of help. This still helps us accomplish the original goal of intervening with students who are about to fail out. While the model does not have a semester-by-semester resolution, we can concentrate on those at the low end and flag the students whose semester grades have recently dropped.

This model has most directly been applied to the discussion over admissions standards, where it will allow us to place an admissions cut-off point. We would be able to exclude the students who are most likely to drop out and lower SSU's retention statistics.

Utilizing Logistic Regression to Assist in Determining Admissions Standards at Shawnee State University

Arthur Bogard, Senior Mathematical Sciences

Shawnee State University

Fall 2010

$$\frac{1}{1 + e^{-k}} k = B_0 + x_1 * B_1 + x_2 * B_2 \ldots \ldots$$

This Thesis submitted to Dr. Robert Mendris in partial fulfillment

of the degree of Bachelor of Science in Mathematical Sciences

The Study, Background

Early in the fall of 2010, Dr. Timothy Hamilton approached me with some ideas regarding how to predict student graduation rates based on information that can be gleaned by the admissions process. The state of Ohio decided to alter how it allocates funds to universities, and criteria no longer included student enrollment, but rather, graduation rates, student retention, and course completion. As Shawnee State University historically has horrible graduation rates, we needed to come up with a model by which we could eliminate students from applying who had poor chances of ever succeeding, thus establishing admissions standards.

Dr. Hamilton's initial thought was to perform a linear regression on the information, but as graduation is a binary variable (success or failure), I knew that linear regressions would not be a good way to proceed. We approached Dr. Douglas Darbo about the problem and asked him what he thought of the study. His first instinct was to perform a logistic regression on the data. This regression model works for predicting categorical data instead of the scalar data that linear regressions predict. I performed some additional research on the subject and determined that the logistic regression was indeed the proper way to proceed and began teaching myself anything I could on the logit function and how to properly perform logistic regressions using SPSS.

Coordinating with Kim Patton and Jonica Burke in the Department of Institutional Research, we devised a plan in which we could identify variables and request them to be included in the study. Our data set contained only students who started in the fall of 2002, 2003, and 2004 to properly predict graduation rates as defined by the state. After cleaning the data, I found were several students who were added to the data set who did not start in the fall; those students were removed. We began with a data set including ACT scores, student information from each semester, AGE, and a variety of other variables. This data set did not include important information for admissions standards such as ACT sub-

scores, high school GPA, class rank information, etc.   This was added later and required significant time and effort to integrate into the data set.

During the course of the study, it became apparent to me that missing information was going to limit our ability to properly model the student population. Graduation rates among students who provided all of their information (ACT, class rank, GPA) were significantly higher than among the students who did not provide information. Removing these students from the study, although appealing from a time-investment standpoint, was something I wanted to avoid, so I then had to begin researching missing value analysis. After studying missing value procedures (a very new feature in SPSS), I then employed my new knowledge on the data we had and was able to rerun the analysis with all student information present.

Methods Used

Logistic Regression

When most people think of statistical regressions, they think of the linear regression. Given a sample of a population, for example, working adults, and a dependent scale variable, say present income, and independent variables such as age, race, and SAT score, a model can be created whereby changes in one of the independent variables creates a proportional change in the dependent variable. In this completely made up sample set, suppose that for every year older a person is, that is holding all variables equal and increasing a person's age by one year, their income is predicted to be $5,000 greater. This is a linear model.

Many other regression models exist including polynomial, binomial, and exponential regressions. All of these regression models require the dependent to be a scale, or numeric, value. What if a researcher wanted to predict the outcome of a Bernoulli, or binary, variable with a true or false value? What about predicting group membership of a nominal variable, a variable with no natural order, with more than three subgroups?

Predicting group membership requires a different approach. Instead of looking at output magnitudes of dependent variables, this requires looking at probabilities of group membership. For example, if someone wanted to find out whether or not a student at Shawnee State University was likely to eat lunch in the cafeteria, that would be considered a binary output value. Either the student doesn't eat in the cafeteria (fails), or does eat in the cafeteria (succeeds). A researcher would examine a variety of variables he or she feels is important to predicting the student's success or failure to eat in the cafeteria and would run a binary logistic regression. Output values would be a probability of the student's success or failure, and they would range in the open interval from zero to one.

If the researcher instead wanted to examine whether a student was going to eat in the cafeteria, at home, in his dorm, or in a restaurant, he would run a multinomial logistic regression. Instead of examining group membership between success and failure, he's now looking at group membership among several different outputs and wants to predict which group the student will most likely belong to. Output values in the multinomial logistic regression instead include a probability for each membership case.

In the accompanying study, I examined the probability of a student to succeed or fail to succeed to graduate at Shawnee State University. As I only examined group membership between two outcomes, a binary logistic regression made the most sense. A multinomial logistic regression could be used in this case, but in order to use one of the most useful goodness of fit tests available for binary variables, the Hosmer and Lemeshow Test, a binary logistic regression is required. A multinomial regression may be desirable should we decide to try to predict graduation, transfer, and failure to graduate in order to identify students who will potentially leave SSU for another university.
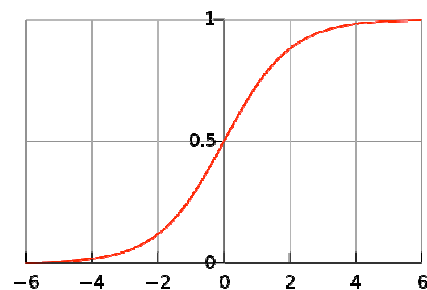
P-axis, SD on x-axis

Logistic regressions are counterintuitive in many respects. Most people think about linear regressions when considering how variables interact in a model. As previously stated, no matter what the other variables do in a linear model, an independent variable always influences the dependent variable by a set amount. In the logit model, a variable's influence on the model depends on the other variables of the model. When examining the model in **Figure 1**, one can see that the largest change in probability of the model occurs within two standard deviations of the mean (just as likely to succeed as not to succeed). Changes in a variable can still measure the magnitude of a variable's influence on the model as measured by its beta coefficient, but one cannot draw any inferences on how much a variable will affect the probability of group membership without knowing the values of the other variables.

Log Odds and Odds Ratio:

Interpretation of the logistic regression output is not as simple as a linear regression model. For a linear regression, we mainly examine the beta coefficient of a each variable, and although all the variables combined tell us the exact output value for the dependent variable, the beta value lets us know how one unit change of an independent variable impacts the dependent variable. Take the following fictitious example equation:

$$ACT\,Composite = 4.2 * HSGPA + .18 * Income(In\ \$10,000s) + 5$$

If this were an equation for predicting ACT Composite scores for students, controlling for all other variables, for every 1.0 increase in GPA a student would increase his or her ACT score by 4.2. Likewise, for every increase in household income, we would see an increase in ACT score of .18. In this model, our β_0=5, so all students start off with a GPA of 5, our Y-Intercept.

In the logistic regression, we're dealing with an entirely different beast. Instead of determining a scale value where each variable acts independently of one another, variables have Log Odds and Odds Ratio. Log-Odds, or Logits, are the beta coefficients of the logistic regression equation: $logit(p) = a + b_1x_1 + b_2x_2 + \cdots$ These logits are essentially slope values, and we can interpret this as the change in the

average value of Y from an increase of one unit of X, similar to the linear regression. But, unlike the linear regression, the beta values are not calculating the changes in the dependent variable, but rather changes in the log odds of the dependent variable.

So, what does this all mean? This odds value is predicting the probability that a case exists in one group or the other (a dichotomous variable). The odds value can range from 0 to infinity, and it indicates how much more likely that an observation is a member of the target group (1) than the other group (0), so it's the probability of existing in the target group divided by the probability of existing in the existing group. If the probability is 0.60, the odds are 3:2 for membership in the target group (.60/.40); if the probability is 0.90, the odds are 9:1; for .99, the odds are 99:1, and for a probability of .50, the odds are 1:1. This log odds requires us to examine all of the variables within the model to determine group membership.

The odds ratio (OR), allows us to examine the individual variables alone and how they influence the model. This is highlighted by the Exp(B) value, or the exponential value, which takes the beta coefficient of the variable and raises the log e to that power. This gives us a ratio influence of the variable. If a variable has a B=2.01, then the Exp(B)=7.46. This means that for every one point increase in the variable, the odds of success increase by 7.46 times. This is a useful tool, but one has to always remember scale when comparing variables. If we are comparing ACT Scores to Income in predicting whether someone owns a home or not, if the ACT score is a significant predictor, it's going to have a much larger Exp(B) value than Income due to income ranging from 0 to a million dollars or more. We have to scale things to make comparisons, and we still can't always make good comparisons for saying that one variable is better than another when it comes to raw influence on the model. This is a problem that many statisticians face: statistical significance vs. practical significance.

Hosmer and Lemeshow Test:

An important step in any model is to analyze whether or not the model fits the data. SPSS and other statistical software do not employ heuristic methods to determine the best model for a given set of data; rather, a software package will generate a user specified model for any set of data entered into the database. This gives the user power to decide which model he or she would like to employ, but it also leaves open the possibility that the model will not fit the data.

For example, if the observed scale outcome of a dependent variable for a population tended toward a horizontal asymptote (a nonlinear outcome) one could use a linear regression to explain the data, but it would do a poor job at explaining it. When running linear regression models in SPSS, a glance at the Normal P-P Plot of Regression Standardized Residuals assists in determining if a linear model is appropriate for the data.

When looking at whether a logistic regression model is appropriate for the data, one observes the Hosmer and Lemeshow chi-square test of goodness of fit. This is an optimized chi-square goodness of fit test that breaks the probability distribution into ten parts examining probabilities between 0, .1, .2, etc. The point of the HL test is not to prove that a logistic regression model is appropriate for the data, but rather, that it is not *not* appropriate for the data using the variables selected for the model.

For an example of a bad HL test, we examine a binary logistic regression using ACT Reading scores as the only predictor for student success at Shawnee State University given the compiled dataset and listwise deletion for missing data. This gives us an HL score of p=.002 which tells us that the logistic regression model does not describe the data properly. When examining the **Figure 2** which is a histogram of graduates and non graduates and their predicted probabilities using just the Reading Sub-Score, we can see that although we are predicting failure pretty well, we're predicting success along a very similar curve meaning that the logistic regression does not work properly for this data.

Predicted Probability
Figure 2
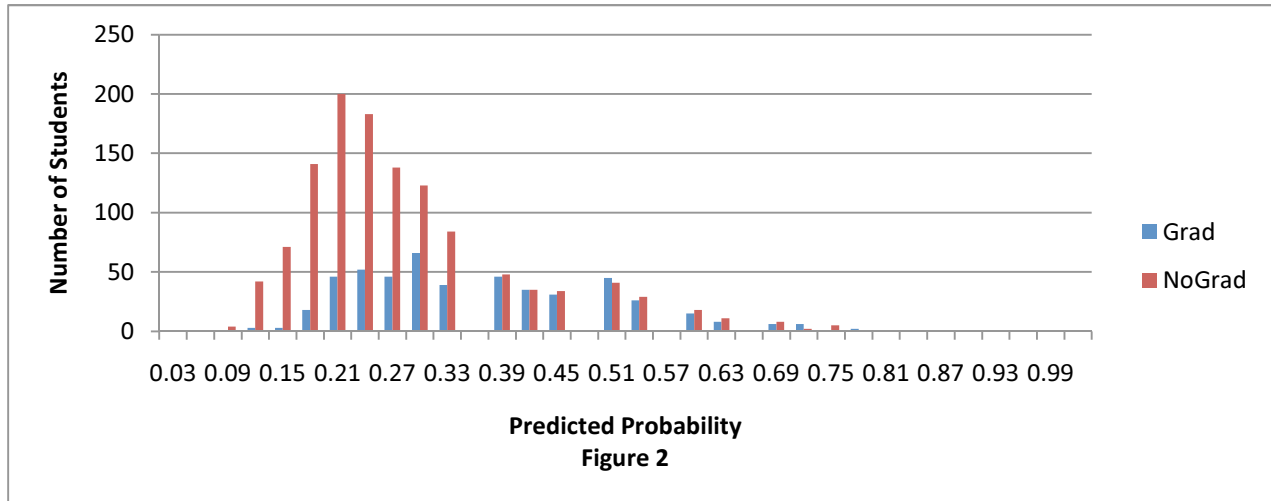
Stepwise Logistic Regression:

In aggregate statistical studies where the researcher does not have direct input into what variables are collected and how, deciding what variables to include in a study becomes an increasingly complex and difficult task. As such, researchers have devised a variety of ways to determine the factors with the greatest influence on a model. Stepwise models are models that either add or remove variables from a model in order to determine the most statistically significant variables in a model.

A backwards stepwise approach begins with the researcher including every variable he or she wants to possibly include in the model. The regression is run, and the most statistically insignificant variable is removed from the model. The regression is then run again. As they say on shampoo bottles, "lather, rinse, and repeat" until every variable in the model is statistically significant. In essence, the model is developing backward from the largest model to the smallest model possible. Criticisms exist for this method, most notably that when a regression is run with too many variables, the regression fails to have enough power to truly say anything about the model. After several iterations, the remaining variables have enough power to predict success or failure, but some fear that legitimate variables may be discarded under this method. Also, many adhere to the motto: simple is better, and backward stepwise regressions tend to have more variables than their counterparts, forward regressions.

Another approach to dealing with many variables includes the forwards stepwise method. In some ways the inverse of the backwards stepwise approach, the forward stepwise method runs each predictor against the dependent variable. It adds the most significant predictor, runs the model, and if the model is significant, it then reruns the analysis with the remaining variables until either no more significant variables are left or the model contains a statistically insignificant variable. There are other methods for selecting which variables to keep including using likelihood and comparing the next model iteration with the previous one. This method is often used by data mining services, but many argue that it is being used as a poor substitute for proper subject matter expertise or knowledge of the dataset.

Missing Data

Listwise and Pairwise Deletion

The most common and most simple approach to dealing with missing values within cases is to omit the cases in question and run the analysis on the remaining cases. Listwise deletion is the default action in SPSS, but it causes bias when dealing with non-random cases. For example, in our study, we have 1152 cases with ACT math sub-scores out of a total set of 1675 cases. In other words, only 68.8% of cases include ACT math sub-scores. Of those cases with math sub-scores, 29.9% graduated within the allotted time of six years for a bachelors degree and three years for an associates degree. Of those without ACT math sub-scores, only 5% graduated within the allotted time for the respective degree. If a regression is run on the sample of only those students with ACT math sub-scores, the resultant model would be heavily biased toward graduates. Under listwise deletion, we would remove any case that does not have a complete set of information. Using listwise deletion, this data set would be whittled from 1675 cases down to 1069 cases, or only 63.8% of possible entries.

Pairwise deletion, like listwise, removes cases depending on the variables being used. If a case does not include AGE, that case would not be used in any correlation matrix using age, but it would be used in other correlation matrixes not using age. This method is sub-optimal and is often referred to as

"unwise deletion" because each parameter in a model will be determined by a different data set with different sample sizes and standard errors. In either of these cases, should we assume that missing information is randomly distributed with no inter-correlations, then we can use either of these methods. In most cases, such as ACT math sub-score, missing cases are not random. Listwise and pairwise deletion methods are often appropriate when dealing with missing data such as AGE in our dataset. AGE only has two cases with missing information, and although both cases are failures to graduate, the influence of removing approximately 1/10th of a percent from the model is not significant.

A common thing to do when missing cases is to treat the lack of information as information itself. Coding a true-false dummy variable, we can compare cases without one piece of information. With the case of ACT math sub-scores, we can use the lack of having the information as a predictor in the stead of the actual score. This method often causes problems as observed in the study with lacking resolution in the final binary logistic regression model. Rather than having a scale variable with many values, we have a binary variable with only two outcomes, true or false.

Regression and Mean Substitution

Rather than throwing out cases that could help better form a model, a variety of methods have been developed. The Census Bureau of the 1940s and 50s developed a method called hot deck imputation. This method would take missing data and replace it with information from another case of similar ethnicity, gender, and age. This method worked well enough in the 1940s and 50s due in large part to the relatively small about of missing data on submitted census cards. As missing information became a larger issue, other methods came into usage.

Mean substitution is the process of examining the mean of all other cases for a particular variable and replacing the missing data with the mean. This procedure does not influence the mean of the variable in question, and the larger sample size does allow the case to now be used in regressions

for other data. The problem is that this method underestimates the standard error for a variable and

increases the central tendency of the model.

Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
HighREAD	1152	10	31	18.53	.101	3.421	.717	.072
VAR00001	1675	10	31	18.53	.069	2.837	.865	.060
Valid N (listwise)	1152							

Table 1

For instance, if we examine **Table 1**, HighREAD is a person's highest reading sub-score on the

ACT. Notice that we only have 1152 total students who submitted their ACT reading sub-score to

Shawnee State University. VAR00001 is the same measure with the values of the missing data replaced

by the mean of HighREAD. We can see that the maximum, minimum, and mean values have stayed the

same, but the standard error, and therefore distribution spread, significantly decreases. As mean

substitution adds no new information to the variable, it is illogical to expect it to increase how

comfortable one is with the estimate of the mean.

Another substitution method that has the same inherent issues with mean substitution is

regression substitution. In this case, we use other variables to predict the outcome of the variable with

missing information. We then generate a model, and should we develop a perfect model, again, no

useful information is added to the data. Also, for information such as ACT scores where students are

not linearly assigned a value, but rather assigned a score dependent on their percentile placement, this

hurts our ability to predict with the variable rather than helps it. This method also only works should

you have all of the information for the other variables being used to predict a cases' score.

Multiple Imputation

Multiple Imputation is a newer statistical method developed in the late 1980s to better deal with missing information than "hot-deck," deletion, or other substitution methods. It uses a similar method to mean substitution, as it uses other variables to predict the proper value for missing data, but the key word, the key difference is the term "multiple." In MI, variables are imputed several times using the same predictors, but with "randomness" added to preserve spread. MI also allows the user to define minimum and maximum values, as well as precision. For example, if one were to impute ACT scores unbounded, it's possible that a person could end up with a -1, a 37, or a 19.24454. None of those responses is a valid value for ACT score, as ACT scores are defined between 1 and 36 rounded to the nearest whole number.

An issue with any missing value analysis is the "missingness" of the data, or the distribution of how the data is missing. There are three types of missing information, missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR). Missing completely at random data implies that there is absolutely no pattern to the missingness of data. Missing at random data implies that the pattern of missingness is difficult to detect from noise. Missing not at random data is data in which there is a definite pattern to the missingness.

What does the pattern of missingness mean? MCAR is fairly simple; it's essentially the idea that we go into a dataset and randomly select cases to remove information from. There is absolutely no pattern to why the data is missing. MNAR and MAR, on the other hand, are much more difficult to distinguish. Imagine that we've sent out a survey to soldiers returning from Iraq and one of the lines on this survey is asking soldiers to rank their mental well-being on a scale from 1-10 where one is not well at all and ten is excellent mental health. We send out 200 of these surveys and we find that of the 200 sent out, 50 of them have no answer for this mental health question. One could assume that there is no real pattern in this missingness, and that reporting from soldiers with low mental health self-assessments is no different from soldiers with high mental health self-assessments. Here, we would be

assuming that the data is missing at random (MAR). Now, someone in the analysis group looks at this

questions and poses, "wouldn't soldiers, individuals who typically pride themselves in hiding emotions,

not want to report if they felt they had a low mental health state?" In this, he means that he feels

soldiers with lower self-assessment scores would be less likely to report than those with high scores.

This idea, if true, means that the variable is missing not at random (MNAR).

The distinction between MAR and MNAR data means everything when doing missing value

analysis, yet is nearly impossible to prove either one. If data is missing not at random, imputing that

information will ultimately enter incorrect values. Say we decide to use mean substitution assuming the

information is MAR while actually being MNAR, and with the above question, soldiers who answered the

question averaged a 7.2, so we decide to just substitute this in for the values of the soldiers who are

missing in order to use those soldiers other information for prediction. But, later it is discovered

through follow-up that the average score for soldiers who didn't answer the question was 4.3. We've

now biased our estimators positively, taking away the ability to properly predict other variables based

on this question.

This issue of MNAR and MAR goes beyond just the simple means of a variable. In the

experiment of this paper, we're trying to determine graduation group membership based on a variety of

predictors including ACT composite scores. One issue, though, is that we have a significant number of

students who didn't provide an ACT composite score (26.6%). The on-time graduation rate among

students who had an ACT score submitted to SSU was 28.96%. Meanwhile, the on-time graduation rate

among students who did not submit an ACT score to SSU was only 4.67%. Whether a student submitted

an ACT score to the university played a significant role in predicting success or failure at Shawnee State

University. If we were to listwise delete students who didn't submit an ACT score, we would bias our

results to students who will succeed. This also leads us to the question: are missing ACT scores at

random, or not? If we assume students who didn't submit an ACT score are likely to have a lower ACT

score, then we have MNAR data and imputation is much more difficult to reliably impute. We don't

want to bias our model toward graduation, but at the same time, we don't want to use biased

estimators for our model. It's a "catch 22" situation where the statistician has to balance the needs of

the study with the proof of the biased missing information.

Ultimately, for the purpose of this study, I have decided to listwise delete information and avoid

multiple imputation methods. I ran a MI logistic regression model using 2002 and 2003 data in order to

predict 2004 students, and the results did not prove to be ones that I was comfortable publishing in this

paper. With the changing demographics and the increase in ACT submissions, I feel that using current

MI predictors would do a poor job on current students.

Case Study

Data Set

This study examines incoming freshmen at Shawnee State University during the fall of 2002 and

2003. The data set was provided in two parts by the Office of Institutional Research. In the first data

set, the information provided included every student's ID, ethnic information (if provided), Sex, Marital

Status, Date of Birth, age at the start of school, starting declared major, starting declared concentration,

starting full time/part time status, individual courses taken with sections, sessions, year, registration

status, grade achieved, term majors and GPAs, highest ACT composite score, graduation date, and

degree information for every quarter or semester enrolled. The second part of the data released by OIR

included students GPA, Class Rank, Class Size, ACT Sub-Scores, and placement test results.

Procedure

After cleaning the data set of poorly coded and poorly written data, I will be working with the

logistic regression to determine a model that best describes the success and failure rate for the student

population at Shawnee State University (group membership).

Logistic Regression #1:

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	1615	68.3
	Missing Cases	750	31.7
	Total	2365	100.0
Unselected Cases		0	.0
Total		2365	100.0

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	251.214	3	.000
	Block	251.214	3	.000
	Model	251.214	3	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1703.758	.144	.205

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	2.994	8	.935

Classification Table

			Predicted		
			GraduatedWithinTime		Percentage Correct
	Observed		0	1	
Step 1	GraduatedWithinTime	0	1041	100	91.2
		1	330	144	30.4
	Overall Percentage				73.4

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1a	HighREAD	.062	.023	7.389	1	.007	1.064	1.017	1.112
	GradePointAverage	1.257	.135	86.609	1	.000	3.513	2.696	4.578
	HighCOMP	.053	.024	4.941	1	.026	1.054	1.006	1.104
	Constant	-7.127	.466	233.667	1	.000	.001		

Correlation Matrix

		Constant	HighREAD	GradePointAverage	HighCOMP
Step 1	Constant	1.000	-.072	-.543	-.381
	HighREAD	-.072	1.000	-.273	-.586
	GradePointAverage	-.543	-.273	1.000	-.131
	HighCOMP	-.381	-.586	-.131	1.000

Interpretation:

When looking over this regression model, we can make several notes. First, we notice that roughly one-third of incoming freshmen for the falls of 2002, 2003, and 2004 are missing at least one of the predictors: GPA, ACT Composite, ACT Reading. This lends us to believe that our results are going to be biased toward students who gave ACT scores and their high school GPA. When looking at GPA, only 14.4% of students failed to provide a high school GPA. Of those students who did not provide high school GPA, 63% did not provide ACT Composite scores and 74.4% did not provide an ACT Reading sub-score. On the other end, 28% of students did not provide an ACT Reading sub-score, and 26.2% of students did not provide an ACT Composite score. As students who have no ACT score graduate with ~4% on-time graduation rate, having an ACT Composite score was compared to not having one.

The table below indicates having an ACT composite score vs. not having an ACT composite score against success in graduating on time is a significant predictor (Pearson $X^2=154.5$ $df=1$ $p<.001$) for on-

time graduation success. Although other analysis were done using the absence of ACT as a predictor,

changing admissions standards at the university would make these test mostly moot.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	154.515	1	.000		
Continuity Correctionb	153.129	1	.000		
Likelihood Ratio	193.214	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	154.450	1	.000		
N of Valid Cases	2365				

The test of the model using GPA, ACT Composite, and ACT Reading sub-score indicates that all

predictors are significant in predicting success or failure to graduate on-time at Shawnee State

University. A test of the full model against a constant only model was statistically significant, indicating

that the predictors as a set reliably distinguished between success and failure to graduate at Shawnee

State University (X^2=251.214, df=3, p<.001).

The Nagelkerke R Square test indicates a moderately weak relationship between the prediction

and the grouping (r^2=.205), but the Hosmer and Lemeshow test strongly fails to indicate that the logistic

model does not describe the data (X^2=2.994, df=8, p=.935). The classification table indicates that the

model accurately predicts 73.4% of success and failure, although it much better predicts failure (91.2%)

than success (30.4%). This differs from the constant only model which predicts with 70.7% accuracy

(100% failure, 0% success).

Multicolinearity does not play a significant role in the model. As we examine the variables in the model, we see that for every increase of one point in ACT Reading scores, the student is 1.064 times more likely than if that increase did not exist. Similarly, for every increase of one point in ACT Composite score, the student is 1.054 times more likely to graduate than if that increase did not exist. Finally, for every increase in GPA of one point, the student is 3.513 times more likely to graduate than if they did not have that increase in GPA. This is a logical outcome, as GPA is typically defined between zero and four. The highest GPA recorded for this data set was 4.669, while the lowest GPA recorded was a 0.99. The highest Reading ACT Sub score was 31 while the lowest was a 10. Finally, the highest ACT Composite score recorded was a 36 while the lowest recorded was a 7.

Examining the probability histogram of students who did graduate, did not graduate, and did graduate, but did not do so within the allotted 150% allowed time for consideration of success, we can see that the model predicts students who never graduated very well, but did not predict the other two categories very well. This is promising for admissions standards criteria, as we can reliably eliminate failures with a much higher rate than falsely rejecting those who would have succeeded.

Predicted Probability of Success
Figure 3
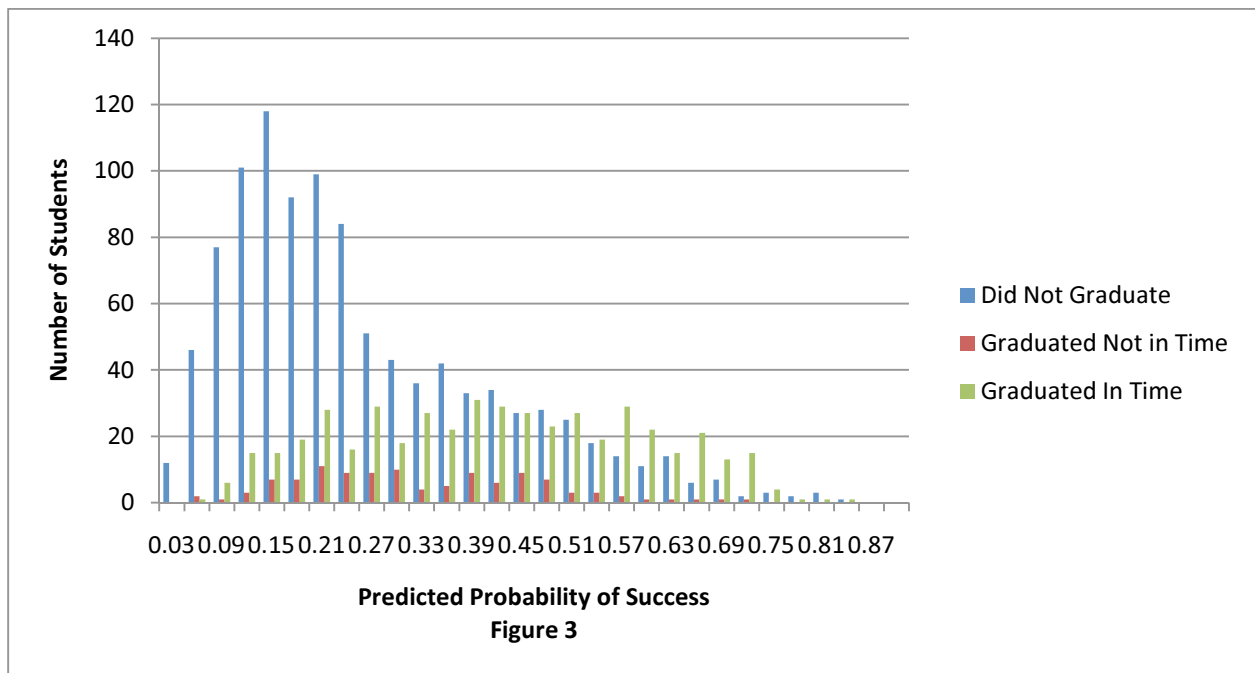
Logistic Regression #2

Next, we examine another logistic model using GPA and comparisons of ACT<19 and ACT>=19 with not having an ACT Composite score at all. In this model, we recode students with ACT Composite Scores greater than 18 as ACT19 and ACT Composite Scores less than 19 as ACT18. This allows us to compare those students falling into these dummy variables against not having an ACT Composite Score at all.

Case Processing Summary

Unweighted Casesa		N	Percent
Selected Cases	Included in Analysis	2025	85.6
	Missing Cases	340	14.4
	Total	2365	100.0
Unselected Cases		0	.0
Total		2365	100.0

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	398.072	3	.000
	Block	398.072	3	.000
	Model	398.072	3	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1845.261	.178	.266

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.914	8	.767

Classification Table

			Predicted		
			GraduatedWithinTime		Percentage Correct
	Observed		0	1	
Step 1	GraduatedWithinTime	0	1420	114	92.6
		1	342	149	30.3
	Overall Percentage				77.5

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1a	GradePointAverage	1.493	.122	150.717	1	.000	4.452	3.508	5.651
	ACT18	1.296	.298	18.897	1	.000	3.656	2.038	6.559
	ACT19	1.815	.280	42.063	1	.000	6.141	3.548	10.627
	Constant	-7.305	.447	267.494	1	.000	.001		

Correlation Matrix

		Constant	GradePointAverage	ACT18	ACT19
Step 1	Constant	1.000	-.800	-.520	-.437
	GradePointAverage	-.800	1.000	-.023	-.170
	ACT18	-.520	-.023	1.000	.863
	ACT19	-.437	-.170	.863	1.000

Again, as we examine this model, it significantly outperforms a constant only model (X^2=398.072, df=3, p<.001). This model, because it now includes students who do not have ACT scores, does a better job at predicting success and failure vs. the previous logistic model. The Nagelkerke R Square indicates an increase to .266 from the previous model's .205. The Hosmer and Lemeshow test has decreased to .767 from .935, but we still fail to prove that this logistic regression model does not describe success and failure. Our predictive success has increased to 77.5% of the population (92.6% failure prediction, 30.3% success prediction).

The most important measure, though, will be on the following pages. As we examine a comparison of the two models against one another and hard ACT cut-off scores in truncating students, we want to work to minimize false rejection rates of students while still rejecting the same number of students in total. Using **Figures 4-9**, we will examine histograms of the predicted successes and failures of students vs. their actual performance at SSU. We will also see a comparison of the models in raw number form for rejecting students from the bottom of the histograms.

ACT Reading Subscore
Figure 4

ACT English Subscore
Figure 5

ACT Math Subscore
Figure 6

Figure 7

Logistic Model #1

Figure 8

Logistic Model #2

Figure 9
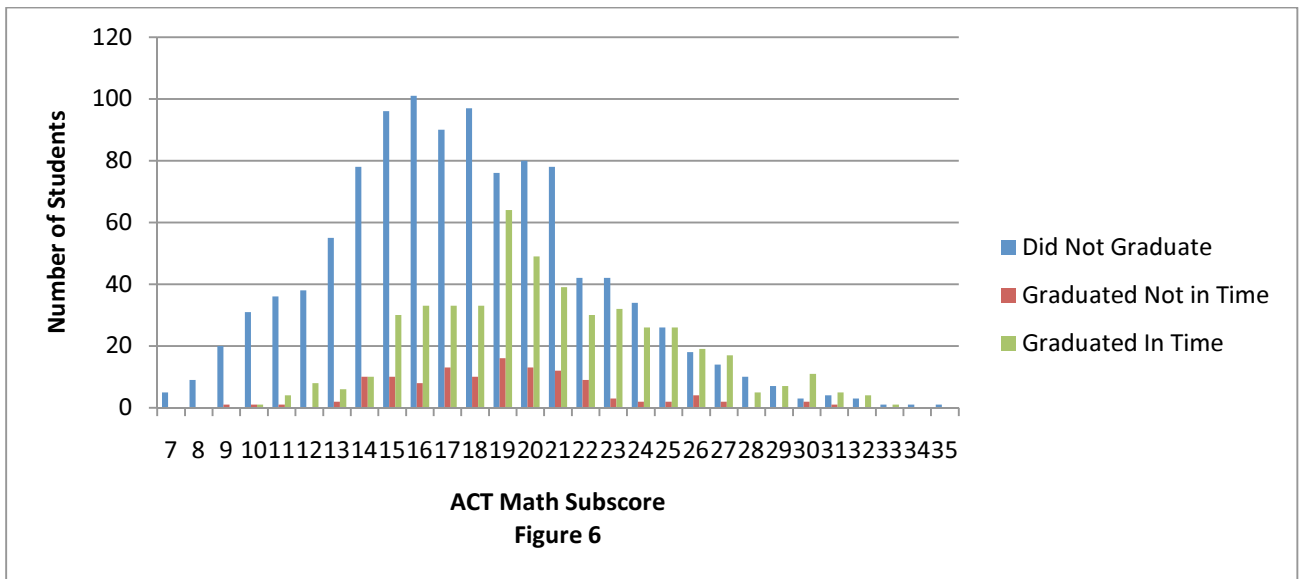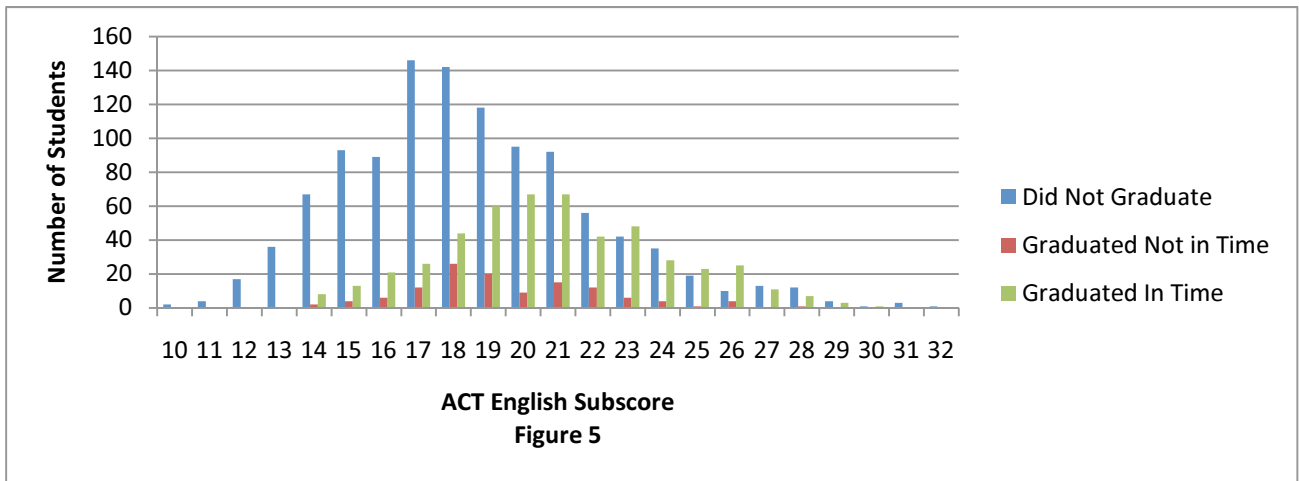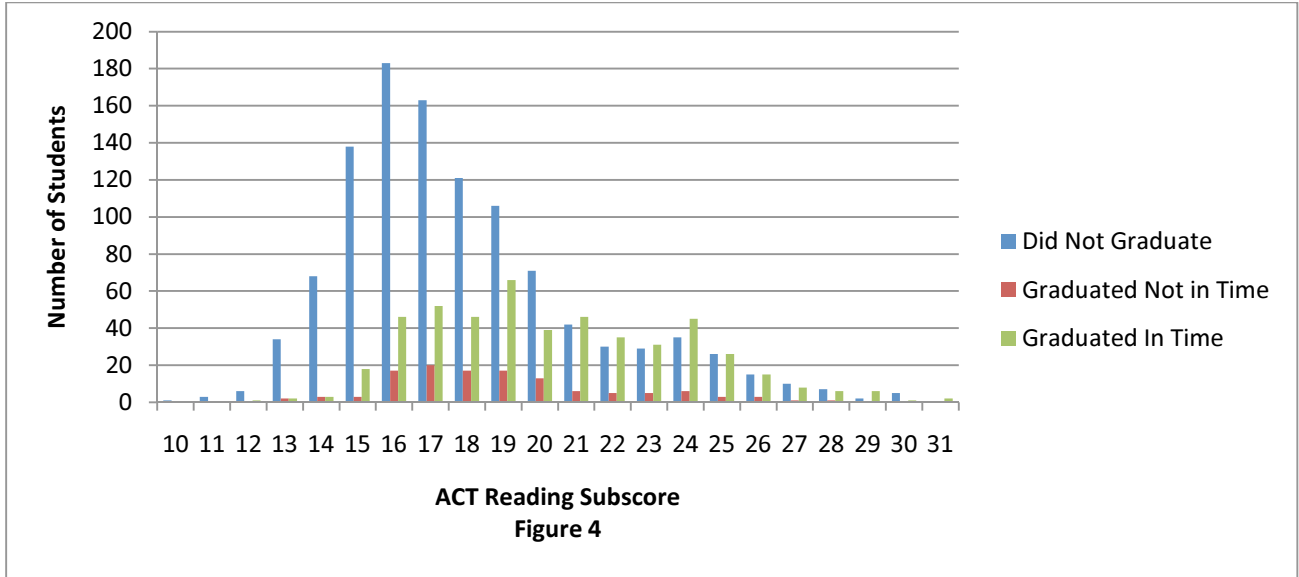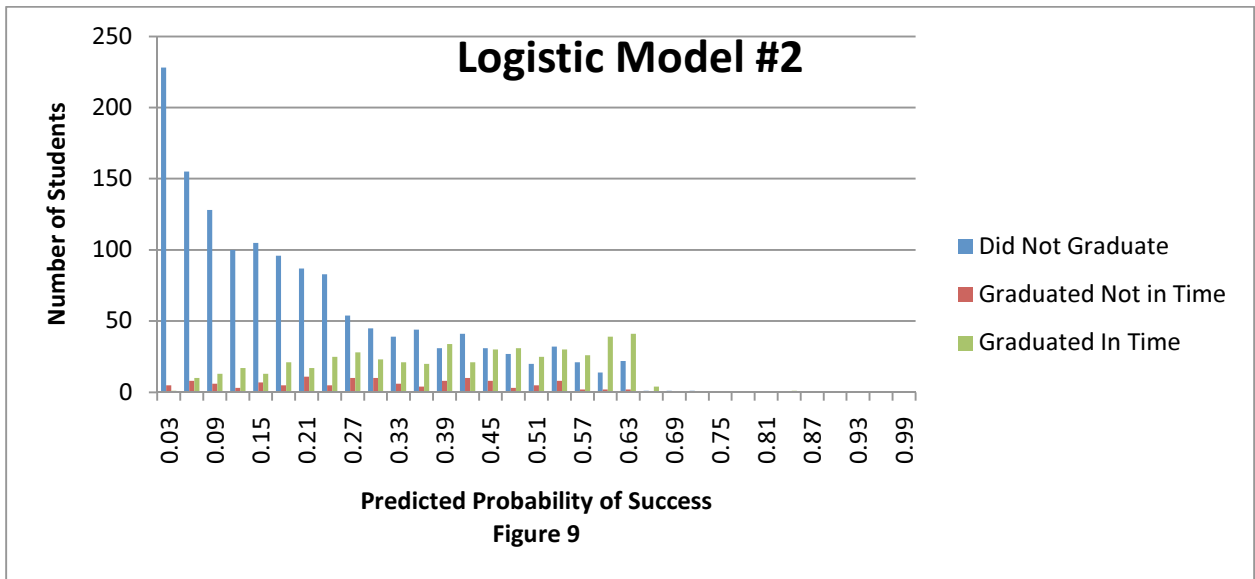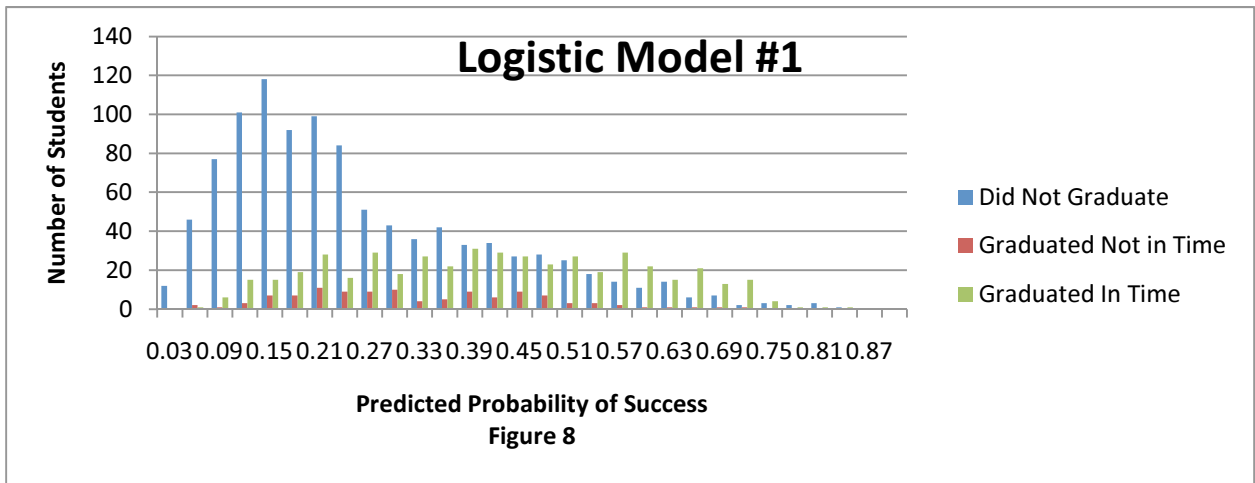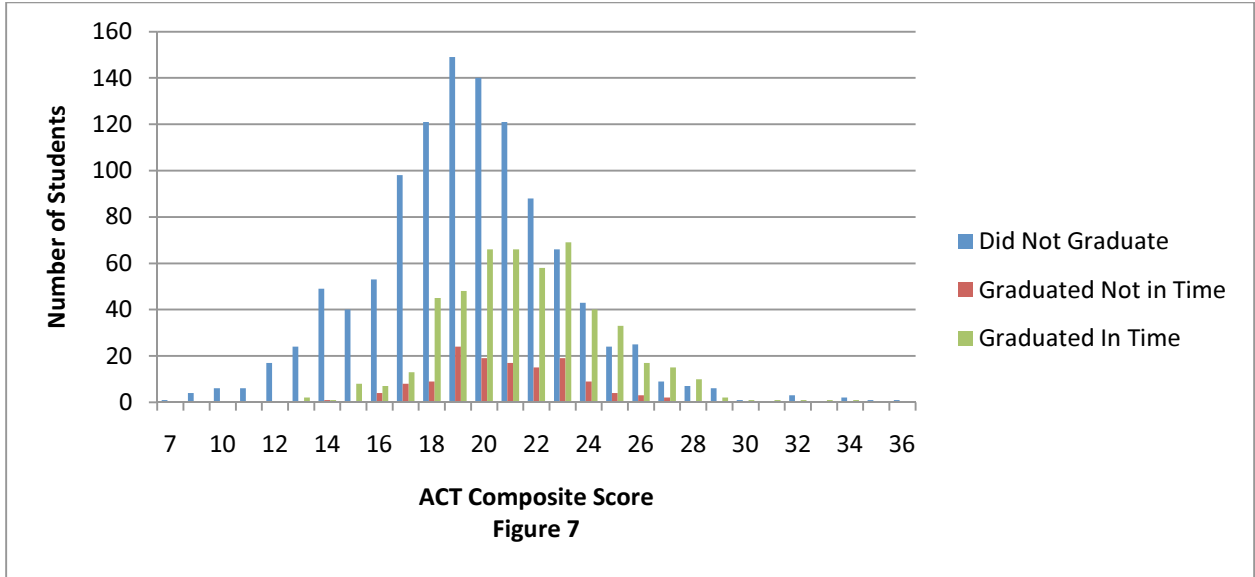
Determining hard cutoffs for admissions standards is a very difficult question with much farther reaching effects on the lives of potential students. Logistic regression modeling using High School GPA, ACT Composite Score, and ACT Reading Sub-Score proves superior to simple ACT cutoffs when eliminating fixed numbers of students, but ACT does provide a possible "good enough" model. In the future, as SSU begins collecting more (and more consistent) information on students and increases selectivity, the regression model will provide the most adaptable and effective method for admissions criteria. Below we compare the following logistic equation to ACT and Sub-score hard cutoffs.

$$\frac{1}{1+\left(\frac{1}{e^k}\right)} \quad k = -7.057 + 1.249*GPA + .05*ACTComposite + .063*ACTReading$$

$$Model\ 2\colon k = -7.305 + 1.493*GPA + 1.815*(if\ ACT>18) + 1.296*(if\ ACT<19, but\ has)$$

2/102-Regression@.08	2.0% false rejection
3/111-ACT (AT 14)	2.7% false rejection
6/123-READ(AT 14)	4.9% false rejection
5/109-MATH(AT 11)	4.6% false rejection
8/136-ENGL(AT 14)	5.9% false rejection
1/234-Regression2@.03	0.4% false rejection
27/317-Regression@.13	8.5% false rejection
31/342-ACT (AT 17)	9.1% false rejection
24/282-READ(AT 15)	8.5% false rejection
29/316-MATH(AT 14)	9.2% false rejection
42/362-ENGL(AT 16)	11.6% false rejection
11/407-Regression2@.06	2.7% false rejection
56/522-Regression@.18	10.7% false rejection
76/517-ACT (AT 18)	14.7% false rejection
70/528-READ(AT 16)	13.3% false rejection
59/452-MATH(At 15)	13.1% false rejection
68/546-ENGL(AT 17)	12.5% false rejection
24/554-Regression2@.09	4.3% false rejection
93/729-Regression@.23	12.8% false rejection
124/738-ACT (AT 19)	16.8% false rejection
122/763-READ(AT 17)	16.0% false rejection
125/730-MATH(AT 17)	17.1% false rejection
112/758-ENGL(AT 18)	14.8% false rejection
54/799-Regression2@.15	6.8% false rejection
157/952-Regression@.31	16.5% false rejection
190/963-ACT (AT 20)	19.7% false rejection
168/947-READ(AT 18)	17.7% false rejection
158/870-MATH(AT 18)	18.2% false rejection
172/956-ENGL(AT 19)	18.0% false rejection
92/1036-Regression2@.21	8.9% false rejection

Something else we can use to help us decide what methods to use for admissions standards is what other institutions do with their admissions.

- Ohio State University
  - o Three primary factors
    - Successful completion of college prep curriculum
    - Performance in HS as shown by class rank or GPA
    - Performance on the ACT or SAT
  - o Secondary Considerations
    - Attending competitive high school
    - Taken accelerated courses (honors, AP, IB)
    - First generation college student
    - Provide cultural, economic, racial, or geographic diversity
    - Demonstrate outstanding talent in particular area
    - Extracurricular activities, work experience, leadership positions
- University of North Carolina
  - o College preparatory curriculum as outlined by the state standards
  - o ACT>15, SAT>700 (increasing to 17& 800 in 2013)
  - o High School GPA>2.0
- Washington State University
  - o Guaranteed admission
    - Top 10% of graduating class
    - GPA>3.5
- Penn State University
  - o Combination of factors
    - GPA counts for approximately 2/3rds of decision
    - SAT/ACT
    - Class Rank
    - Personal Statement
    - List of Activities
  - o High School Requirements for 4yr and 2yr degrees
  - o ACT/SAT waved for adult students, vets, and others who qualify
- Ball State University
  - o Combination of factors
    - High school curriculum
    - Completion of college prep requirements
    - GPA
    - GED Scores
      - Average: 520, Writing 500, Math 500, Min 450 in each of the remaining sections
    - Grade trends
    - SAT/ACT scores
    - Extracurricular activities
- MIT
  - o Combination of factors not disclosed
    - Appears to be modeled

Discussion:

Time Predictors for Graduation?

Because of requirements by the Department of Education relayed by Tim Hamilton and the

Admissions Standards Committee, this round of data gathering included students who entered into the

university in the falls of 2002, 2003, and 2004. As the population of Shawnee State University students

continues to evolve from non-traditional students to the more traditional on-campus student, it's

imperative to find correlations that will allow the university to use a more modern dataset.

Two of the ideas considered are the correlations between students who do not return for three

consecutive quarters or two consecutive semesters and students who do not return at all. If the study

can conclusively demonstrate that students who drop out for three consecutive quarters or two

consecutive semesters are extremely likely not to return, it would allow the researchers to go back and

begin analyzing more recent datasets to minimize this time-bias. The problem with this idea ended up

being that we would be able to better predict failure of students to graduate, but we did nothing to help

predict success of students to graduate which is just as important as predicting failure. We found

extremely high correlations between students who did not return for a full year and those students who

never returned at all, but the implications of this need to be further studied to determine if this method

will allow us to better model students.

Recommendations

Data Collection Requirements

I have no recommendations for an effective model to use to determine graduation rates among

students due primarily to poor data gathering techniques. Over the course of this study, it has become

abundantly clear that Shawnee State University needs to implement data gathering standards. My

recommendations for information that is required for data gathering include:

SSU should require an ACT score and subscores to be submitted to SSU prior to acceptance. ACT Reading sub-scores in particular provide a strong predictor for student success and failure. ACT Mathematics sub-scores have proven to be a better predictor for student placement into a class than the Compass test. Advising will also play a key role in determining student placement into classes, so this is not a recommendation to abandon advising once a student has been admitted.

A high school transcript with GPA, Class Rank, and Class size information should be submitted, and with that, it might be worthwhile to examine the socioeconomic status of the school (is it Title 1? Is it under academic emergency? If so, how long? Etc). A breakdown of the student's performance (GPA) in classes between English, Mathematics, Science, Social Science, and Elective courses might also reveal significant predictors for student success, although my gut tells me that ACT subscores will do well enough. GPA breakdown might assist in determining not what the student knows, but how dedicated they are to the learning process.

GED students. Individuals applying with a GED should submit and record their sub scores. These scores will better help us model individuals with GEDs to select the best candidates for admission. While many people get GEDs for reasons other than inability to complete high school course work, GED students are grouped into the category of students that did not submit high school GPA and class rank. These students consistently performed worse than those students with high school information (24% on time graduation vs. 12%).

Extracurricular activity breakdown. On an online application, students would be able to check a variety of common extracurricular activities including Boy Scouts, 4-H, various sports, debate team, choir, band, etc. Should students have additional activities not listed, they would have the opportunity to list them at the end. Activities would be broken down into subcategories of Sports, Social, and Academic. As potential students submit new activities, these would have to be manually classified, but

these activities may provide predictors into student success and may also help the university target

clubs and organizations to that student to help retention.

Socioeconomic information. Using the information provided by the FAFSA, SSU may be able to

determine likelihood of a student to be able to financially support themselves throughout college via

their initial Estimated Family Contribution (EFC). This is something that needs to be examined further

and can be added to the current data set with the proper time investment.

Essay submission. This is a task that would require the largest investment by SSU in determining

eligibility. I'm unsure whether this would be a significant predictor for student graduation rates, but

requiring all students to submit a small essay, much like other universities do, to be graded by either the

university staff or an outside consulting agency may provide another strong predictor for student

success and failure. The hypothesis for this is two-fold. First, it would weed out students who are just

applying to the university for the sake of applying and getting financial aid for somewhere. Requiring

students to invest time into the process of applying ensures SSU is getting serious students who want to

attend the university. Second, as communication is such a significant predictor for student success at

the undergraduate level, the score may provide insight into how the student is going to perform in

classes that require written communication.

Encourage departments not to lead students on and to streamline student graduation under the

wire. Of the students who did graduate from SSU, only 77% did so on time. Targeting students who are

approaching their time deadline with assistance to fast-track them to graduation will help improve those

statistics. For example, students entering the university as Pre-Health Science account for 34% of the

students who graduated but did not do so on time while only accounting for 22% of the students who

graduated on time. Also, SSU needs to ensure that departments with admissions criteria do not keep

students in the "holding pattern." If a student does not qualify to enter a program, they need to be

encouraged to pursue other options. Telling a student his or her chance of being accepted into an

individual program as part of the university acceptance process might also prevent those students from entering the university in the first place.

Encourage "No Degrees." Students who are just here for some continuing education need to be excluded from these statistics, and it needs to be encouraged. Providing a credit-hour discount to students who do not apply for admission in the "normal" way might encourage many people, especially the part-time students to not pursue the government options. People who start at SSU part-time are less likely to graduate on-time than those who start as full time (6.4% vs. 23.2%). They make up a small proportion of SSU's population, but it is an area that can be improved.

Withdrawal timeframe (Speculation). The university needs to balance how long a student has to withdraw from courses prior to it being indicated on their transcript and reported to the state. Many other universities have withdrawal periods of up to three weeks, and isolating an idea number here would allow students who are not cut out for the college lifestyle to leave without hurting student retention and graduation numbers.

The Final Word:

The results of this study have multiple implications in recruitment, targeted assistance to students, and admissions standards to improve graduation rates at Shawnee State University. Missing information tended to be the biggest problem when determining proper admissions guidelines (logistic regression model missing 31.7% of cases due to missing information on students, model 2 missing 14.38% of cases).

When working on recruiting students, Shawnee State University should focus heavily on recruiting students in high school and fresh out of high school. As observed in the Graduation Rates by Age analysis, the group of students who best improve the mean graduation rates for SSU are those who enter the university at age 18. Not only do eighteen year old applicants have higher on-time and overall graduation rates (28.413% on-time vs. 13.384% for all other ages; 35.69% overall vs. 18.93%), but they

also occupy a much higher proportion of the on-time graduating population (76.92%) than they do the overall student body population (61.09%).

When targeting students with help, Shawnee State University needs to examine several factors. First, SSU needs to determine how it can help improve graduation rates for students who have been out of high school for a year or more. Nontraditional students occupy 39% of the student population while only making up 23% of the on-time graduating population. Also, SSU needs to focus on getting students to graduate on-time. Comparing on-time graduation rates (22.5793%) with overall graduation rates (29.1755), it is apparent that SSU is allowing students to take their time while getting a degree. This difference in graduation rates increases in some areas to more than nine percentage points such as with the case of Pre Health Science students (20% vs. 29.1525%). This "holding pattern" for admissions into departments needs to be optimized to encourage students who are not suited for a particular career field to go into another field early in their college careers, if possible, prior to being accepted to Shawnee State University.

Looking at the trends extracted from student information, one thing is clear: there are underlying characteristics to missing information that needs to be addressed prior to creating hard cutoffs. The university needs to improve its data gathering abilities to help better model potential student populations prior to making sweeping decisions on student admission guidelines.

About the logit model (for those who don't know the term): the logit model is nothing like a linear regression. The logistic regression provides interplay between variables, and depending on other variables, one variable can have more or less of an effect on the probability of group membership. Whereas in a linear regression, a beta coefficient always influences the outcome of the dependent variable by a set amount, a logistic regression's beta coefficients depend on one another to determine the probability of a variable. Therefore, we use another measure called Exp(B) which tells us holding all other variables equal, a change of 1 for a variable's value increases the probability of success by a

certain amount of times. For example, in the first regression model stated, the Exp(B) of GPA is 3.486.

This means, for an increase of 1GPA point, a person is 3.486 times more likely to graduate than without

that 1 point increase. It still doesn't tell us the probability that they will graduate, and thus must be

taken in the context it is given.

There are a few approaches that can be taken when it comes to admissions standards. It is my

recommendation that these steps be taken slowly to examine the impact of standards on the number of

students enrolling in the university.   First are steps that can be taken without determining hard cutoffs.

- Require either the ACT or SAT for admission into the university
  - This requirement alone will probably decrease the number of students who apply to the university. Students without the ACT graduate on-time at rate of 4.67% vs. students with an ACT score who have an on-time graduation rate of 28.96%.
    - We can reject the null hypothesis that having an ACT has no influence on graduation rates (p<.001, X^2=154.5, df=1).
  - ACT Reading sub-score proves to be a significant predictor of student success in the logistic model detailed (p=.006, Exp(B)=1.066, B=.063)
  - ACT Composite sub-score proves to be a significant predictor of student success in the logistic model detailed (p=.038, Exp(B)=1.051, B=.050)
- Determine university enrollment numbers prior to accepting or rejecting students
  - By determining how many students the university will accept ahead of time, the university can better shape its numbers while minimizing false rejections (students who would have graduated but were rejected due to admissions standards).
- Require student transcripts with GPA, Class Rank, and Class Size (If GED, require sub-scores for future modeling)
  - Students with GPA information graduated at a rate of 24.25% vs. 12.65% for those without. GPA proves to be a significant predictor of student success in the logistic model detailed (p<.001, Exp(B)=3.486, B=1.249)
    - We reject the null hypothesis that having a GPA has no influence on graduation rates (p<.001, X^2=22.408, df=1)
- Design an online application system capable of expandability requiring more information from applicants
  - It is hypothesized that students who have previous employment, participate in extracurricular activities, or assume leadership roles perform better in college.
  - Universities such as OSU make exceptions based on AP course, first generation college students, or outstanding talent. OSU and other university also now require a standardized test WITH a writing exam to determine admissions eligibility.

- System should integrate Extracurricular Activities, Work Experience, ACT/SAT scores, High School Transcripts, GED Transcripts, FAFSA information, High School competitiveness status, and other relevant information as determined by future admissions standards committees.
- SSU should determine application deadlines to properly review student information and make informed decisions about student enrollment.
- Online system could automatically reject and accept students based on set criteria while flagging other applications for personalized review while providing superior tracking and reporting information for the Office of Institutional Research and instructors looking to model student populations.

One final section that did not fit in anywhere else...odd observations:

Age as a predictor?

At first glance, and first regression for that matter, I thought that age was a valid predictor for college success. When running the analysis using stepwise regressions, age constantly popped up as a heavily correlated with success, but each time, as it was added, it decreased the Hosmer and Lemeshow test statistic. I debated including age in the final results, and it's not really a usable variable when determining admissions standards. As I began setting up tables, I noticed something that popped out at me. It was definitely a "duh" moment. When viewing a table of age versus success in college, it's notable that eighteen year old students outperform almost all other ages in graduation rates.

So, why was age a positive predictor for graduation, yet older students graduate at lower rates than eighteen year olds? Simple. Older students are more likely to graduate, in that no student of zero years of age ever graduated from Shawnee State University. Further, students seventeen years of age and older always equaled or outperformed students under seventeen years of age. Under a linear regression, this would have been immediately noticed by using a normal probability plot of residuals when observing the residuals jumping above and below the line, but with the logistic regression, this was not nearly as evident. Sometimes, just laying the data out is the best way to catch mistakes.

Experience of other schools

Outline
1. School description
2. What prompted the change?
3. What standards were developed?
4. How were the standards implemented?
5. What were the effects of the change?
6. School contacts

1. School description

Texas Southern University
Enrollment (undergraduate and graduate) 11,635. Tuition is $3,732. Mostly black student population.

Georgia College State University
Total enrollment 6,700 students, with ~5,700 undergraduates. In-state tuition & fees ~$4,000/semester. There is a freshman residential requirement. They have few non-traditional students.

Nichols State
Enrollment 7,093. In-state tuition is $3,595. Part of the University of Louisiana system. Originally a junior college.

Indiana University East
Total enrollment 2,459 students (2,392 undergraduates). In-state tuition ~$5,000. Branch campus of Indiana University; former community college. Started in 1971 as a community college. Started issuing bachelor's degrees in the 1980s and especially 1990s, then began master's degrees later. Officially changed away from the community college aspect in 2005 but shares a campus with the new state community college. There is no on-campus housing.

2. What prompted the change?

Texas Southern
      State pressure to increase graduation rates.

Georgia CSU
      A few things came together at once. In 1996, they were designated as Georgia's public liberal arts university. The state has minimum admissions requirements, which they were already above, but they wanted to change their admissions to improve.

Nichols State
      A Board of Regents mandate.

Indiana U East
      Immediate reason is that enrollment had dropped dangerously, due to competition with the new state community college next door. IU East needed to focus on traditional students to avoid competing and carve out its own niche. In addition, the state also has performance-based funding.

3. What standards were developed?

Texas Southern
- HS GPA $\geq$ 2.0, ACT > 17, SAT > 820
- Might change to HS GPA $\geq$ 2.5 by 2012, but no change in ACT/SAT.
- They offer a "summer academy" for students marginally below the cut-off. It is 6 weeks long over summer, targeted for assistance in particular subjects to prepare students for the fall.

Georgia CSU
Uses a holistic approach without absolute cut-offs in any single parameter (*i.e.*, there is no minimum HS GPA or SAT). Instead, admissions looks at all of the following:
- HS GPA
- rigor of HS curriculum
  - gives more value to AP, honors, and dual-enrollment courses
- ACT and SAT scores
- involvement in extracurricular other school activities
- what kind of program the student is looking to get into
  - *e.g.,* lower-end students are unlikely to get into the nursing program

The freshman class is capped at 1,200 students.
- 1,100 traditional freshmen
  - Freshmen registration begins in February
  - ~99% of them come to summer orientation
    - Get accustomed to campus and meet their advisors
- 100 lower-ranking students are brought in over the summer
  - Have probationary status
  - Take a 5-week program to catch up to college-level work
  - They wind up with a higher retention rate than the rest of the freshman class

Note that years before the change to admissions standards, Georgia CSU was the first public university(?) in Georgia to require students to complete all college prep courses (advanced English, math, etc.) before entering.

Nichols State

First-time freshman, under 25 years of age, must meet the following criteria in order to eligible for admission to Nicholls State University:

1. Meet the Board of Regents Core (TOPS Core)
2. Require no more than *one* developmental course
3. Have a minimum 2.0 HS grade point average
4. Meet *at least one* of the following:
   1. Have at least a 21 composite ACT
   2. Have an overall 2.35/4.00 grade point average
   3. Rank in the top half of their graduation class

- Nicholls State University may admit students who do not meet all stated admissions requirements in accordance with the Board of Regents Master Plan. Nicholls State University will consider first-time freshmen with an ACT composite of at least 16. Admissions decisions will be made considering each applicant's potential for success and will include factors such as ACT score, special talents, and the University's commitment to a demographically diverse student population. To be considered for an exception, students must have a minimum 2.00 high school GPA.
- All transcripts for Louisiana graduates after 2003 are downloaded from the Louisiana State Student Transcript System. The unweighted grade point average, as reported by STS is what is used to determine admission.
- Students that are not admitted are encouraged to attend one of the Louisiana Community/Technical colleges. Transfer students may be admitted to Nicholls State University that do not meet the above criteria once they have at least 12 hours of non-developmental courses with at least a 2.00 GPA and require no more than one more developmental.

Transfer Students (in-state and out-of-state)
- Must meet the following minimum admissions criteria:
  1. 12 minimum College Level hours earned
  2. Minimum GPA of 2.0 on College Level Courses
  3. Require not more than ONE developmental
- Additional Criteria:
  1. Students must be eligible to return to the institution from which they are transferring.
  2. Students desiring to transfer with the minimum GPA on college level courses, but less than the minimum college level hours earned, must also meet the freshmen admissions criteria in order to be admitted as transfer students.

Nicholls State University may admit students who do not meet all stated admissions requirements in accordance with the Board of Regents Master Plan. Nicholls State University may set aside a limited number of exceptions of the entering transfer class. Admissions decisions will be made considering each applicant's potential for success and will include factors such as special talents and the University's commitment to a demographically diverse student population.

Indiana Univ. East

For traditional students (coming *immediately* from high school):
- o Student intention to earn bachelor's degree.
- o Require the state's "core curriculum" in HS (or equivalent for out-of-state students). This includes college-prep English and Algebra II.
- o HS GPA ≥ 2.0
- o SAT or ACT (test required but only used to determine fate of borderline applicants)
- o There is an internal cut-off on scores in the admissions office, used for these marginal applicants (taken from NAIA cutoffs for sports eligibility):
  - SAT (combined) ≥ 860, w/at least 400 in each of Math & English
  - ACT (composite) ≥ 18, w/at least 18 in each of Math & English
- o Put most emphasis on HS college prep curriculum and on HS grades in math & English. If these are low, then look at the SAT/ACT scores.

For non-traditional students (any applicant out of HS for more than *one semester*):
- o SAT/ACT test not required

They have added a Summer math bridge program.
- o Not required but highly recommended for students with poor math grades or poor math SAT scores.
- o Free
- o 4-week program, just before classes begin in the Fall.

Option of being admitted but taking remedial courses at the community college.
- o There's an official agreement between the institutions; students can be enrolled in both at the same time.

4. How were the standards implemented?

Texas Southern

First to their curriculum committee and then to the board. The admissions office was given authority over the actual implementation of the standards.

Georgia CSU

The Enrollment Management Office started the process. The Faculty Senate vetted the actual standards, using data provided by the Enrollment Management Office to the entire faculty.

Nichols State

Created by the Board of Regents.

Indiana Univ. East

The Executive Vice Chancellor for Student Affairs worked with the Faculty Senate committee chairman to come up with the formal suggestion to convert to admissions standards. This proposal was apparently taken through the Faculty Senate. The Chancellor was given ultimate authority over what the standards are, and he has delegated this to the Exec. Vice Chancellor for Student Affairs, who reports to the Faculty Senate on how it is going.

The change was mostly phased in over two years, from Fall 2007-Fall '08. Initially they set some soft cut-offs and then raised them the next year. In addition, associates' degrees were dropped in Fall '08, and remedial courses were dropped in Fall '09. It has taken about 4 years to get a stable set of standards. They are still making minor changes now.

5. What were the effects of the change?

Texas Southern
- o Enrollment: They got a minor drop in freshman enrollment for the first two years. The (total) student population went down about 5% from 9357. But this can't be put down entirely to the admissions standards; other factors came into play about this time. Enrollment has now recovered to the initial levels, partly through an improvement in the graduate student enrollment and the growth in on-line programs.
- o Racial/ethnic makeup: Unchanged.
- o No problems, overall.
- o **[Note improvement in progression rate and how much time it will take to see effect on graduation rate]**
  - Currently, retention rate is 59%; graduation rate is 15% [from http://www.blackcollegesearch.com/texas-colleges/texas-southern-university.htm]

Georgia CSU
- o Retention and graduation rates both went up.
- o Better performance. The average entering SAT score increased another 18 points this year.
- o The school's profile went up, but the enrollment of minority students went down at first and then back up a bit.
  - Drop was bigger for black students than for Hispanic.
- o The school now attracts more affluent students; they are not seeing the needier students applying any more.
- o Expectations of students are higher.
- o Parental involvement is more prevalent
  - Not just their keeping an eye on their children, but also demanding more out of the college. (*E.g.*, no more 8 AM classes, saying a roommate is unacceptable)
- o They still see a lot of students transferring in from 2-year colleges.
- o Overall, a change for the better.

Nichols State
- o Better quality students
- o Increased retention rate

Indiana Univ. East
- o *No decrease in enrollment!*
  - By clearly distinguishing their mission (focus on traditional students and bachelor's degrees) from the neighboring community college, they gave students a clear choice. Non-traditional students and those wanting associate's degrees go to the community college, instead.

- Biggest change is in age and HS preparation. Freshman class is now ~92% teenagers.
- Not much change in ethnic distribution, but there is a change in socioeconomic distribution. Before the change, they had been one of the highest Pell Grant institutions in the country. Now they're still high but have dropped.
- Expanded admissions staff to handle HS recruitment.
- Added online degree completion programs.
  - There are 7 of them now.
  - These are available for students who transfer in as juniors or seniors.
  - Attractive to non-traditional commuter students.
  - Expect these enrollments to exceed in-person enrollment in a year or so.
- No real drawbacks. Considering they were facing such a severe drop in enrollment before that they might have shut down, this is all up-side.

6. School Contacts

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Georgia CSU
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