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SAT and ACT Scores as Predictors of Undergraduate GPA Scores of Construction Science and Management Students

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American College Test (ACT) and Scholastic Aptitude Test (SAT) scores have been part of the admission requirements for many Construction Science and Management (CSM) undergraduate educational programs in the United States of America (USA). This is because academic programs and admission committees tend to believe that these scores could aid in predicting the academic performance and success of students as measured by their Undergraduate Grade Point Average (UGPA). This research assessed the predictive ability of admission ACT and SAT scores on the cumulative graduation GPA scores of CSM undergraduate students from two universities in the southeastern part of the USA. The hypothesis was that students who scored higher on the ACT or the SAT would attain higher UGPAs when they graduate from college. The independent variables were the ACT and the SAT scores with the dependent variable being the UGPA score. SAS v9.4 facilitated the statistical analysis of the data obtained from two CSM undergraduate programs in the USA. The result showed relatively strong positive correlation and predictive indices for both ACT and SAT. Thus, the hypothesis of higher UGPAs being related to higher ACT or SAT scores was supported. It was concluded that the admission committees might need to re-examine their admission requirements and/or look at ACT score more than SAT during admission.

Key Words: ACT, Construction Science and Management, Predict, SAT, Undergraduate GPA

Introduction

Both Scholastic Aptitude Test (SAT) and American College Test (ACT) are achievement tests that assess prior knowledge and learning of students who want to pursue undergraduate education. They are called aptitude tests that evaluate learning potential in specific domains (e.g., academics). They are also called intelligence tests that measure general intelligence, mental, or cognitive abilities important to performance and success in college education (Coyle et al., 2014; Frey & Detterman, 2004). About 90% of four-year academic programs in the USA require students who have completed their high school education to sit and pass either the SAT and/or the ACT in order to secure admission into college or undergraduate educational programs (Zwick, 2007). A survey conducted by the National Association for College Admission Counseling (NACAC) indicated that SAT and ACT scores are ranked second in the hierarchy of factors considered in admission decisions after high school grades (Hawkins & Lantz, 2005). College preparatory courses, strength of previous high school curriculum, extra-curricular activities, and demonstrated interest in the academic institution are among other student measures usually considered in the admission decision process (Clinedinst, Hurley & Hawkins, 2011). These measures are believed to accurately identify those students who are ready and would eventually succeed in college education (Radunzel & Noble, 2012).

A review of some of the CSM programs in the USA shows that they require students to take and report their SAT or ACT scores. The admission committees of these CSM programs emphasize the aptitude test scores because they believe that the scores have the ability to predict performance and success of CSM students (Wao et al., 2016). The CSM programs are more interested in identifying and admitting students who are more likely to finish successfully than those who would be enrolled for one or two years of their college career and drop out or transfer to other programs. More emphasis has been placed on college readiness and ultimate performance and success of students because current employers expect undergraduate college graduates to have near impeccable writing, high-level thinking and problem-solving skills in response to the fast, ever changing and increasing demands of available jobs (Hart Research Associates, 2006; Autor et al., 2003). In this regard, the educational community is emphasizing the

so-called 21st century abilities or skills, in addition to knowledge in specific domains, in hopes of promoting the development of critical thinking, problems-solving, communication, collaboration, innovation and creativity skills (Arum & Roska, 2011; Porter et al., 2011).

The pressure of admitting able and would-be successful students is the goal of admission committees in the CSM programs. The committees may focus on admitting students who they believe would perform well in the end. This discourse requires a clear definition and effective measure of college or undergraduate educational success.

Therefore, this research investigated the SAT and ACT scores as predictors of UGPA scores of students from two CSM programs in the USA. SAT and/or ACT scores of students were the independent variables used as predictors of undergraduate performance and success. Cumulative UGPAs of students at the end of their college education was the measure of success. Predictive ability of SAT or ACT scores was assessed using quantitative statistical methods.

Literature review

The nature of SAT and ACT as standardized tests

The SAT is a standardized test for college admission consisting of three sections: Critical Reading, Writing, and Mathematics subtests. Each section earns a maximum of 800 points for a combined total of 2400 points for the three sections. The average score on the SAT is 1500. The ACT, an aptitude test administered by the American College Testing Program, has subtests comprised of English, Mathematics, Reading and Science, with the ACT composite score representing the aggregate performance across the ACT subtests. A student's raw score for a section in ACT is converted into a scaled score which ranges from 1-36, the lowest being 1 and 36 as the highest score. Students receive a scaled score for each of the four multiple-choice test subsections; English, Math, Reading, and Science. All high school students can take the SAT, ACT or both for college admission irrespective of region or background.

Investigating the reliability of SAT and ACT scores as predictors of undergraduate educational success

Research show varied outcomes concerning the ACT and SAT scores as predictors of undergraduate success. One body of research held that standardized tests like the ACT or the SAT are not valid predictors of long-term college success of students (Soares, 2012). A study by Ellrich (2014) that examined the use of SAT scores to predict college success measured by GPA scores in the academic areas of elementary education, early childhood education, secondary education, and special education found that the SAT was not a good predictor of college success. The study also examined qualitative factors such as extra-curricular involvement, community service, service learning and leadership roles in the application process as equally important indicators of student success. They surveyed the students to look into their extra-curricular participation prior to college as scored on their application evaluation.

Other research show that both SAT and ACT scores could be valid predictors of college success. A study by Bridgeman et al. (2000) and Noble (2000) concluded that both SAT and ACT could be predictors of college GPA for the first year. Some other studies have demonstrated that ACT scores and high school GPA (HSGPA) are valid measures of early success in college as defined by first year college GPA (Allen & Robbins, 2010). Additionally, some researchers believe that SAT score validity does not only rest on its ability to predict first year college grades but also the grades in the subsequent years (Patterson & Mattern, 2010). Ideally, CSM programs would be more interested in long-term college successes that translate into better performance in the construction industry.

Other studies have investigated the long-term college success of students. A study by Coyle and Pillow (2008) about SAT and ACT predictive ability on college GPA showed that SAT and ACT correlated moderately with college GPA ($r = 0.31$) while Bridgeman et al. (2000) showed SAT also correlating moderately with college GPA ($r = 0.34$). Radunzel and Noble (2012) conducted a study to predict long-term college success through successful graduation using ACT composite scores and HSGPAs by using hierarchical linear modeling to estimate probabilities of college success. The results showed that both ACT composite scores and HGPAs were effective in predicting long-term college success. Research by Westrick et al. (2012) involving 50 four-year academic institutions found that first year college GPAs correlated highly with ACT composite score ($r = 0.51$) and HSGPA ($r = 0.58$). Sackett et al. (2009)

found a similar index of relationship between SAT scores and 1st year UGPA. Zahner et al. (2014) conducted a study to predict college success measured by college GPA. They predicted UGPA at midpoint and at the end of their college careers using HSGPA and SAT/ACT. They found through simple and multiple regression analysis that HSGPA was the best predictor of UGPA but not for sophomores. These correlations increased when using both SAT and HSGPA. That is, SAT contributed positively in predicting college success. Cornwell et al. (2008) examined the relationship between new SAT scores on college GPA where test structure, content, and scoring was changed in addition to introducing the SAT writing section. Regression analysis was used to control personal characteristics such as race, gender and parental education. From it, the SAT score was effective in predicting academic success.

Some studies have investigated performance between high and low achieving students in order to find any predictive differential between the two groups. Coyle et al. (2011) examined the predictive validity and reliability of SAT scores for high and low ability students using Spearman's Law of Diminishing Returns (SLODR) as a predictive framework. In the study, SAT scores of students greater than 1250 were grouped as high ability and those with less than 1050 were considered low ability students. The results showed that the SAT score correlations with UGPA were higher for high ability students than low ability students. That is, the SAT predicted college GPA better for high ability students than low ability students. The SAT-GPA correlations (adjusted for range restrictions) were modestly higher for high ($r = 0.61$) than low groups ($r = 0.5$). This was the first study that showed the predictive validity of SAT varying for ability groups that differ in intelligence. The result of this study contradicted with the principle of Spearman's Law of Diminishing Returns (SLODR) that states that a test's predictive validity would be lower for high ability subjects. The theoretical framework of the research concerned the mental ability hypothesis of SLODR (Jensen, 1998) which predicts that the mean correlation among cognitive tests decline as the ability level decreases. SLODR thrives on the theory that mental abilities become more independent as ability increases. A study that confirms SAT's predictive validity is higher for higher ability students is Kobrin et al. (2008) while Sawyer (2010) pointed to a similar trend in the ACT scores.

Overall, the review of literature has shown limited research focusing on the CSM discipline that require selection and training of good students who would be successful in their college education by scoring high GPAs. This gap in knowledge motivated conducting this predictive research in the area of CSM programs.

Research Methods

Data were gathered from two CSM undergraduate programs from two universities in the southeastern part of the USA. Descriptive statistics comprising of mean, mode, median, standard deviation, skewness, kurtosis, and box plot distribution showed the variations and distribution of the SAT, ACT and UGPA scores. Correlation and regression analyses were used to determine the relationship and predictive indices among the score variables.

Aim, Objectives and Hypothesis of the Research

The aim of this research was to investigate the predictive ability of SAT and ACT scores on the performance and success (UGPA scores) of students in the CSM undergraduate programs. The first objective was to determine the correlation between entrance SAT and ACT, and cumulative UGPA scores upon graduation. The second objective was to determine the better predictor of UGPA scores between SAT and ACT scores.

The hypothesis was that CSM students who scored higher in their admission SAT and/or ACT would be expected to perform better by scoring higher cumulative UGPAs at the end of their CSM undergraduate education.

Sample Size and Demographics

The original sample size consisted of 160 students ($N = 160$). After data screening to remove errors in score entry, the number reduced to 155 students ($N=155$) who took ACT ($N = 56$) and SAT ($N = 99$) and completed successfully from spring 2013 to spring 2015 semesters. Any student who might have dropped out of the programs was not included in this research because they were not able to graduate and had incomplete undergraduate GPA score data.

All students had to sit for the SAT, ACT or both prior to their admission and would graduate only after completing the full program requirements. Both universities used these test scores as part of their admission requirements. Therefore, the data reflected the performance in these programs and that the outcome of this research could be generalized or applicable to the population of CSM undergraduate students and programs in the USA.

Data Description, Research Variables and Data Analysis

The data comprised of ACT, SAT and UGPA scores of undergraduate students. ACT scores ranged from 11 to 31, SAT from 620 to 1470 while UGPA scores were from 2.11 to 4.0. The two CSM programs required students to achieve good scores in ACT or SAT in order to secure college admission. In addition, they were highly encouraged to maintain a 3.00 GPA in order to graduate in good academic standing and secure a good job or employment in the construction industry.

In the study, the independent variables were the ACT and SAT scores while UGPA was the dependent variable. Data analysis used SAS v9.4 as the statistical analysis software where the data were analyzed separately depicting ACT vs UGPA and SAT vs UGPA.

Results

Descriptive and inferential statistical results were presented and discussed in relation to predicting the UGPA scores.

Descriptive statistics

Descriptive statistics comprising of mean, median, standard deviation, skewness, kurtosis and minimum and maximum values for the ACT, SAT and UGPA variables were calculated and presented separately. The results are shown in Table 1, Table 2 and Figures 1-4.

Table 1. Descriptive statistics of ACT and UGPA scores

Variable	N	Mean	Median	Mode	Std	Skew	Kurt	Min	Max	Review of distribution plot
ACT	56	23.27	23.5	26	4.83	-0.36	-0.58	11	31	Relatively negatively skewed score distribution
UGPA	56	3.01	3.0	2.43	0.47	0.10	-0.94	2.11	3.95	Normal distribution

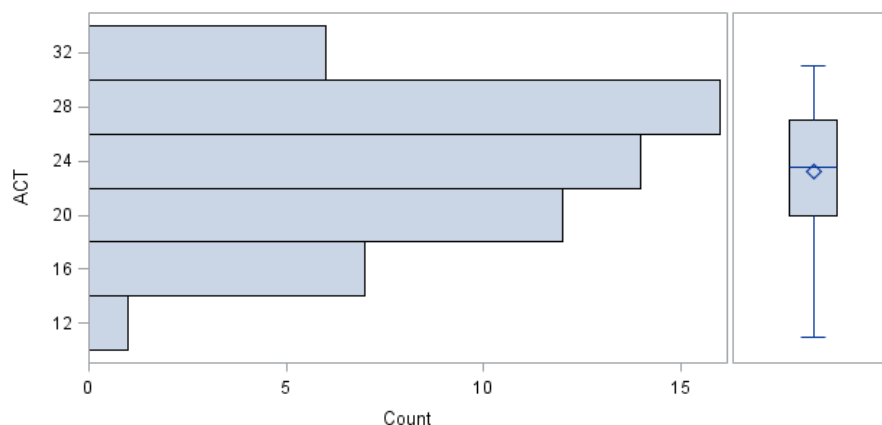


Figure 1. Distribution plot for ACT

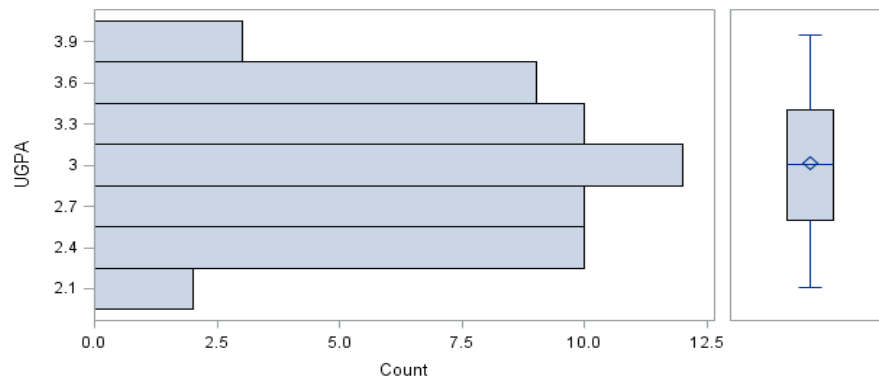


Figure 2. Distribution plot for UGPA

In Table 1, Figures 1 and 2, the distribution of UGPA scores showed a normal distribution while distribution of ACT scores were negatively skewed suggesting that most of the ACT scores tended to be on the upper side of the scale.

Table 2. Descriptive statistics of SAT and UGPA scores

Variable	N	Mean	Median	Mode	Std	Skew	Kurt	Min	Max	Review of distribution plot
SAT	99	1167	1180	1130	160.97	-0.90	1.27	620	1470	Negatively skewed score distribution with 2 lower extreme scores or outliers
UGPA	99	3.14	3.19	3.43	0.42	-0.25	-0.78	2.2	4.0	Normal distribution

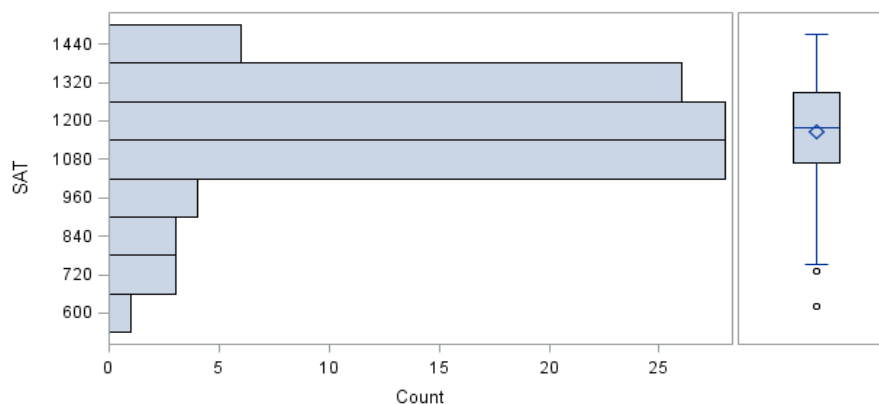


Figure 3. Distribution plot for SAT

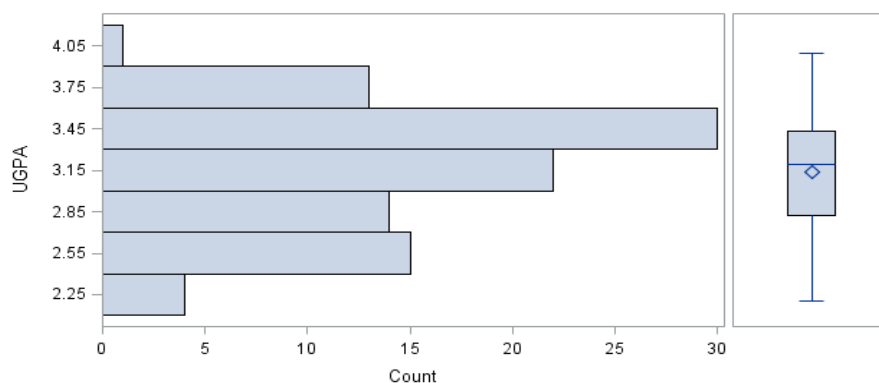


Figure 4. Distribution plot for UGPA

In Table 2, Figures 3 and 4, the UGPA scores were normally distributed while the SAT scores were negatively skewed implying that most of the SAT scores tended to be on the upper side of the score distribution scale. Some of the extreme scores or outliers could have contributed to the skewed distribution of scores.

Correlation between the ACT, SAT and UGPA scores

Correlation analysis investigated the strength of relationship between ACT, SAT and UGPAs of students. Modified Pearson Correlations Coefficients guide was used in the interpretation of correlation indices (Wao et al., 2016). Using the guideline, (+/-0.01 to 0.09 = negligible relationship, +/-0.1 to 0.19 = very weak relationship, +/-0.2 to 0.29 = weak positive/negative relationship, +/-0.3 to 0.39 = moderate positive/negative relationship, +/- 0.4 to 0.69 = strong positive/negative relationship, +/- 0.7 and higher = very strong positive/negative relationship), the correlation between ACT and UGPA was strong positive ($r = 0.46$) while SAT vs UGPA was moderate positive ($r = 0.37$).

Linear Regression of the ACT, SAT and UGPA scores

Simple linear regression analysis assessed the predictive abilities of ACT and SAT scores on GPA scores. The results are in Table 3.

Table 3. Regression analysis of score variables

	N	RMSE	R ²	Standardized Coefficients
UGPA vs ACT	56	0.4182	0.2113	0.46
UGPA vs SAT	99	0.3931	0.1355	0.37

In Table 3, R² estimated the amount of variance in the UGPA score that was accounted for by the independent variables ACT and SAT. Specifically, ACT accounted for 21.13% while SAT accounted for 13.55% of the variance in UGPA. The Root Mean Square Error (RMSE) indicated the magnitude by which the prediction of UGPA tended to be off. The prediction equations were as follows:

- $UGPA = 1.9766 + 0.0444 (ACT)$.
- $UGPA = 2.017 + 0.000962 (SAT)$.

The regression model between UGPA and ACT shows a relatively steeper slope compared to SAT implying a relatively greater positive linear relationship between UGPA and ACT. This is also supported by the statistical significant result (at $p = .05$) of the regression coefficients of both variables. Usually, the interpretation is to reject the null hypothesis if $p < .05$ and conclude statistical significance, or fail to reject the null hypothesis if $p > .05$. The regression coefficient for ACT [$t(55) = 3.80, p = .0004$] and SAT [$t(98) = 3.90, p = .0002$] were found to be statistically significant making both tests useful predictors of UGPA. However, looking at the R² values may prompt a decision maker to believe that a student who scored higher in the ACT at the time of admission would be more likely to perform better in the CSM undergraduate program compared to those who took SAT.

Discussion and Conclusion

The review of literature has shown different outcomes in the effort to determine the predictability of UGPA from the admission ACT and SAT scores, with some showing resistance in the usage of the scores while others agree that the two tests could be useful as part of the admission requirements. Even though the literature review shows inconsistency in their usages in predicting UGPA, universities and colleges still maintain the use of these tests to admit undergraduate students because they tend to believe that the scores in these tests have the ability to predict performance and success of students in their educational career. Considering the gap in past studies, this research assessed the predictive ability of ACT and SAT on cumulative graduation UGPA of students in two CSM programs in the USA. Different descriptive and inferential statistical results were central in this predictive research.

The results showed relatively high scores in both ACT and SAT as shown by the negatively skewed score distribution while UGPA was appreciably good enough as shown by the normal score distribution. The negatively

skewed score distribution implied that most students scored relatively high. Students who took SAT tended to score higher UGPAs than those who took ACT. However, this difference is not statistically significant at $p = 0.05$ level.

The correlation coefficients between the UGPA vs ACT and SAT were relatively in the same range when compared to past studies in the area of predictive research. From the statistical analysis, the correlation coefficients between UGPA and ACT ($r = 0.46$) and between UGPA and SAT ($r = 0.37$) were relatively strong. These correlation outcomes strongly supported the hypothesis of higher ACT/SAT scores tending to be associated with higher UGPAs at graduation. However, given that ACT correlated with UGPA better than SAT, one may conclude that ACT could be a better predictor of UGPA than SAT. Thus, admission committees during their initial acceptance of students in the CSM programs may consider looking at the ACT scores more than SAT scores in the quest for higher UGPAs and academic success in the CSM undergraduate programs because its predictive ability tends to be better.

The regression model showed that ACT had a steeper slope than SAT in the prediction model of UGPA suggesting that it could be better than SAT in its ability to predict college success in CSM programs. The simple linear regression coefficients were statistically significant implying that both tests could significantly predict UGPAs of students. Based on these statistically significant results, it would be prudent to confidently fail to reject the hypothesis that the performance and success of students in the CSM education depend on the SAT/ACT scores. That is, those students who score better in the SAT or ACT are more likely to score higher GPAs at graduation. This outcome could provide useful information to admission committees in CSM undergraduate educational programs where they may consider encouraging and admitting able students into their programs.

In conclusion, this current research showed that both SAT and ACT were valid and reliable predictors of UGPA in undergraduate CSM programs. The correlation and regression coefficients between UGPA and ACT/SAT were relatively strong implying relatively good predictive ability of undergraduate educational performance and success. In some of the statistical analyses, ACT showed better predictive power than SAT for the UGPAs of students and so the undergraduate CSM programs and admission committees may reconsider re-assessing their admission requirements. That is, whether they should emphasize ACT scores or require both SAT or ACT scores during admission. This research contributes to the predictive research conducted about the performance and success of students in the CSM undergraduate programs in the USA. Its outcomes could provide useful information to aid CSM undergraduate admission committees in admitting students. In spite of the predictive abilities, CSM admission committees need to realize that SAT or ACT scores may not take into consideration or not fully evaluate a student's will, drive, motivation or persistence to overcome the hurdles and achieve eventual success in college education. The committees need to know that the most desirable graduates by employers are those students who have persevered through numerous life obstacles and who have endured to achieve not only academic success but also life skills. Thus, high GPAs might not be very important or SAT/ACT scores may be small indicators of student success. The outcome of this research could be generalized to the overall CSM educational programs in the USA.

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