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# ACT Scores as a Predictor of Grade Point Average for Problem-Based Learning

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Standardized testing scores are often used as one element in the admission process however, they tend to be used to predict success in lecture-based courses. The Building Construction Science program at Mississippi State University follows a problem-based pedagogy that has experienced enrollment exceeding capacity. Little research exists to determine whether standardized testing scores are a valid predictor of success in a problem-based pedagogy. This could be useful if future enrollment in the program is limited and competitive. The study first analyzed whether a correlation exists between ACT composite score and the degree completion rate. Secondly, the study analyzed whether ACT composite scores and ACT sub-scores are valid predictors of success for students who complete the degree requirements, as measured by the grade point average of students in the problem-based courses. The results indicate that ACT composite score, when combined with admit type, is a more reliable predictor of the likelihood of degree completion than ACT composite score alone. With regard to predicting degree of success among those who complete the degree requirements, ACT composite score alone was a weak predictor while ACT sub-scores of Science, Math, and English were all moderate predictors of grade point average in problem-based courses.

**Key Words:** ACT, GPA, Predict, Problem-based learning

## Introduction

The Building Construction Science Program at Mississippi State University follows a problem-based pedagogy that requires students to actively engage with and propose solutions to hypothetical problems that are often faced in the construction industry. Unlike siloed lecture courses, students are required to engage with multiple content areas simultaneously and work in an iterative fashion to explore a range of possible solutions. Routinely presenting their work to their peers and giving and receiving constructive feedback furthers the students' understanding of the content and allows them to see the wide range of approaches to a particular situation. The program has an eight-semester sequence of problem-based courses wherein the core construction content is delivered. Each problem-based course is six credit hours which are classified as lecture/lab and therefore result in 12 contact hours per week for each course. Successive courses build upon prior courses in content and

complexity so that by the time students reach senior-level courses, they are routinely exploring problems that require them to simultaneously combine topics such as estimating, scheduling, safety, and contracts all in the same project.

This problem-based pedagogy can be complex and requires a lot of attention to detail from instructors as well as students to maximize the effectiveness of this learning style. Because of the high level of engagement required from both students and faculty, the student to faculty ratio is typically lower than would be found in a lecture course. In recent years, enrollment has put a strain on this pedagogy as the enrollment in each course exceeds the target student-to-faculty ratio of 15 to 18 students per faculty member. As the program has grown, so has discussion of the possibility of a competitive and potentially limited admission process. Because the problem-based pedagogy is often the antithesis of the students' academic preparation prior to enrolling in the program, it is critical to evaluate whether the typical predictors of academic success that are used lecture-based courses – such as standardized test scores, high school grade point average, or some combination of these – are valid predictors of success for problem-based learning.

## Literature Review

College entrance examinations have undergone many revisions since their widespread implementation more than 100 years ago. Originally, essay-based entrance exams tended to be structured around the curricula of a handful of college preparatory schools. This placed students from those schools at an advantage over students from other schools (Stewart and Johaneck, 1996). Additionally, when the number of high school graduates quadrupled over a twenty-year period the evaluation of the essay-based entrance exams became problematic. The combination of these factors contributed toward the development of the multiple-choice format largely used today. The current format has a strong basis in military intelligence testing (Stewart and Johaneck, 1996).

The two most common college entrance examinations in the United States are the American College Testing (ACT) Program and the Scholastic Aptitude Test (SAT). Although both tests are multiple-choice, they serve different purposes. The modern-day ACT is intended to measure a student's knowledge of a high school curriculum and is predominantly used in the Midwest and Southern States (Evans, 2015). Each subject of English, math, reading and science has a sub-score ranging from one to thirty-six points and a composite score which is the average of the subject sub-scores. In contrast to the ACT, the SAT seeks to measure aptitude or ability rather than knowledge learned, and includes math, critical reading, and writing. Each subject has a score of up to 800 points. The sub-scores are then added together to produce an overall score out of 2,400 possible points (Evans, 2015). Unlike the ACT, the SAT discourages guessing and scores are reduced for incorrect answers. The SAT is predominantly used on the West coast and in the Northeastern United States.

Despite having been used as a component in the college admissions process for more than 100 years, the literature is mixed on the role that standardized testing scores should play in the admissions process. Opponents of the use of standardized test scores cite studies that show no predictive validity between standardized test scores and college grade point average (GPA) (Soares, 2012). Opponents also point to the racial disparity in the standardized test results, with nearly twice the percentage of White and Asian students achieving the testing benchmarks when compared to African American and Hispanic students in 2019 (Anderson, 2019). It is important to note that some of those who are opposed to the use of standardized test scores are not opposed to the use of the score altogether, but do not believe it should play a predominant or determinative role in the admission process. In recent

years, some universities have changed practice to make it optional for applicants to submit standardized test scores. Other institutions have limited the role the test scores play in the admission process. Since Spring of 2020, due to the Coronavirus pandemic resulting in the cancellation of standardized tests, many universities are relaxing standardized test requirements to make them optional for the next one to two years. However, it remains to be seen if those schools will resume prior testing requirements in the future (Nadworny, 2020).

Proponents of the use of standardized test scores have found a correlation between standardized testing and college GPA. Burton and Ramist found a positive correlation between SAT verbal and math scores and GPA, and an even stronger correlation when those same SAT scores were used in conjunction with high school GPA to predict college GPA (Burton, et al., 2001). Similarly, Noble and Sawyer found a positive correlation between ACT sub-scores and college GPA, and an even stronger correlation when high school GPA was used in correlation with the ACT sub-scores (Noble, et al., 2002). While both of those studies were across all disciplines, Wao et al, conducted a study of 155 construction management students at two institutions and found that both the SAT and ACT were valid predictors of college GPA, but that the ACT score was a more reliable predictor of college GPA than the SAT score (Wao et al., 2017).

Although the literature is mixed on whether standardized testing scores are valid indicators of future success in traditional lecture-based courses, the unique nature of problem-based learning leads to the question of whether standardized test scores are a valid indicator of future success for this pedagogy. A prior study (Herrmann, 2020) explored whether ACT composite score was a valid predictor of success in problem-based learning. That study analyzed the correlation between ACT composite score and the grade point average (GPA) in problem-based courses for construction management students in the Building Construction Science Program. The sample in that study included all students who completed the program from 2011 through 2019. The results of that study indicated that ACT composite score alone is a weak predictor of GPA in the problem-based learning courses (Herrmann, 2020).

Based on the results of the prior survey, this study seeks to determine whether ACT composite scores are a valid predictor of the likelihood of a student completing the degree requirements in a problem-based program, irrespective of the GPA in those courses. This will be analyzed overall, as well as by admit-type – freshmen, transfer, or change of major. The study will further seek to determine whether ACT sub-scores are a valid predictor of the degree of success based on the GPA in the problem-based courses. The second portion of the study will be limited to students who enter the program as freshmen. This is because of the ongoing over-enrollment issue within the program that may allow the results of this study to influence whether and how to potentially make enrollment limited and/or competitive.

## Methodology

After receiving Institutional Review Board approval, the following data was collected for students who enrolled in the Building Construction Science Program from Fall 2007 through Summer 2016: enrollment term, enrollment type, ACT composite and subject sub-scores, overall grade point average (GPA), and the grade earned in each problem-based course, also known as a studio. Based on the grades earned in each problem-based course, the studio grade point average (SGPA) was then calculated. Because first-year studios were not offered every summer during the relevant time period, and because of a grade distribution that was inconsistent with regular fall and spring terms, the

summer studio grades were excluded from the SGPA. Similarly, the program began offering a co-op opportunity mid-way through the relevant time period which also had an irregular grade distribution. Therefore, any student who completed a co-op had that grade excluded from his or her SGPA.

The initial sample size was 319 students and represented all students who had enrolled in the program from Fall 2007 through Summer 2016. Three of those students were enrolled in the program at the time of data was obtained and were therefore excluded from the study. Of the remaining 316 students, those who did not have an ACT score recorded were also excluded from the study. This resulted in a final sample size of 300 students. Of the 300 students included in the study, 90 entered the program as freshmen, 81 entered as transfer students from another institution, and 129 entered the program after changing their major within Mississippi State University. Out of the sample size of 300 students, 150 students earned a degree from the program while 150 did not. Overall, exactly half of all students who enrolled in the program during the relevant time period completed the degree requirements.

Due to different grading scales and different standards of academic rigor among high schools, the focus of this study was on standardized test scores, rather than a combination of standardized test scores and high school grade point average. First, descriptive statistics were used to compare the ACT composite score to the degree completion rate. Then, descriptive statistics were used to compare the ACT composite score for each admit-type (freshmen, transfer, and change of major) to the degree completion rate to see if ACT composite score in combination with admit type was a better indicator of whether students will complete the program. The second part of the study focused on students who entered the program as freshmen and completed the degree requirements. The reason for this focus is the potential for these results to influence a limited and competitive admission process to limit enrollment. Transfer students and students who change their major within the university have all completed college-level coursework and therefore other factors may be more relevant to predicting their success. For the students who entered the program as freshmen and completed the degree requirements an ANOVA analysis was performed to determine whether a correlation existed between ACT composite score and SGPA, as well as each ACT sub-score and SGPA. Finally, simple linear regression analysis was performed for students who entered the program as freshmen and completed the degree requirements to determine whether the ACT composite score, and whether each ACT sub-score, were valid predictors of the degree of success in terms of SGPA.

## Results

Overall, 50% of all students who began the Building Construction Science Program during the relevant period of time completed the degree. The completion rates by ACT composite score are shown in Figure 1, below.

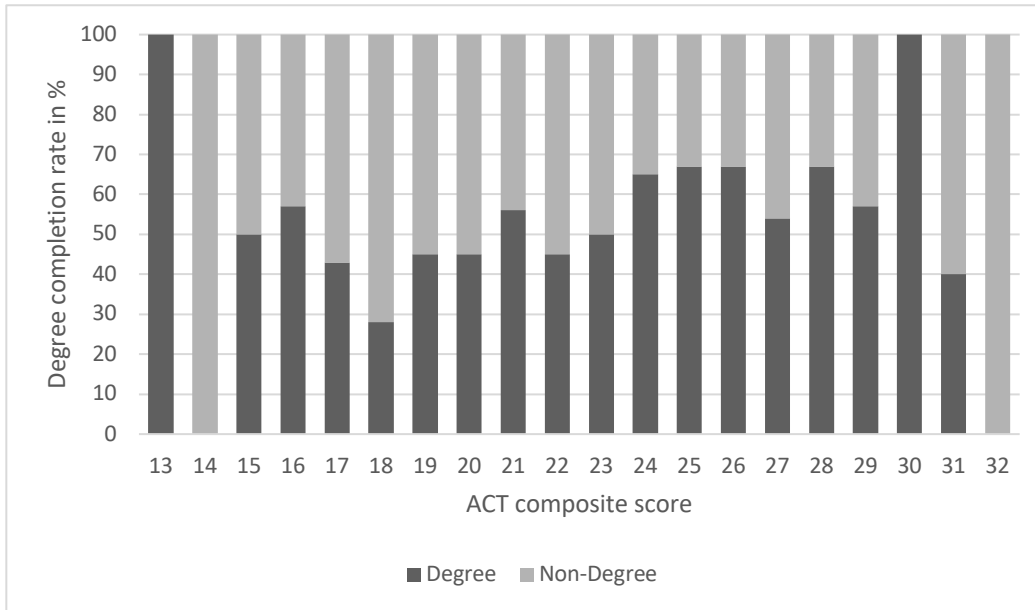


Figure 1. Degree completion rate by ACT composite score

It is important to note the sample size for each ACT Composite in Figure 1 varies. For example, the ACT Composite score of 13 reflects a 100% degree completion rate, whereas the ACT Composite score of 32 reflects a degree completion rate of zero percent. The sample size for each of those scores is only one student. For reasons such as these, the preliminary results are limited. Further analysis was then done to determine whether ACT composite score is a predictor of degree completion likelihood. A comparison of the descriptive statistics of the ACT Composite Scores for students who earned the degree versus those who did not earn the degree are indicated in Table 1, below.

Table 1  
*ACT composite scores of non-degree versus degree students*

	Mean	Median	Mode	Minimum	Maximum
Non-Degree	21.29	21	18	15	32
Degree	22.2	22	21	13	31

Because the results of the descriptive comparison of the degree versus non-degree students were closely aligned, the admit type of each student was then considered. An initial descriptive comparison of the completion rate percentage of each admit type by ACT composite score is shown in Figure 2, below. Incoming freshman had ACT composite scores ranging from 18 to 31. The preliminary results show that for incoming freshmen the likelihood of completing the degree is 50% or less for students with an ACT composite score of 23 or less. For transfer students who had ACT composite scores ranging from 13 to 28 there is no discernable correlation between ACT composite score and likelihood of degree completion. The degree completion rate exceeded 50% for some students with an ACT composite score of 16 and below as well as 25 and above, but there were few students in those sample sizes. For transfer students with ACT composite scores in the middle of the range the completion rates were inconsistent with the other admit types that generally showed a completion rate consistently above 50% once a particular threshold score was achieved. For students who change their major to Building Construction Science within Mississippi State University, the range of ACT

composite scores was from 15 to 30 and the likelihood of completing the degree was 50% or less for students with an ACT composite score of 20 or less.

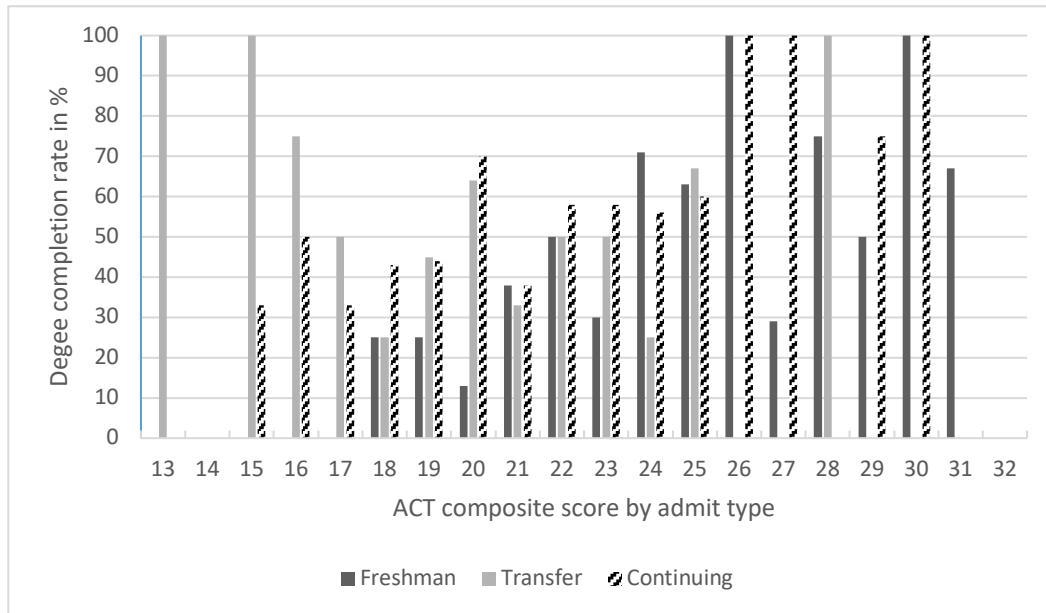


Figure 2. Degree completion rates by ACT composite score and admit type

These preliminary descriptive comparisons may indicate that the admit type combined with ACT composite score may be a better indicator of the likelihood of completing the degree. Because the sample sizes vary greatly within each subcategory and because some subcategories did not have an adequate sample size to allow for further study, future research will focus on ACT composite scores in the range of 18-25 because the sample sizes for those scores range from 37 to 71. In contrast, the sample sizes for ACT composite score ranges of 13 to 17 and 26 to 32 all had 25 or fewer samples and some only had one or two samples to consider.

While the first part of the study focused on success as measured by degree completion rate, the second part of the study focused on success as measured by grade point average in problem-based courses (SGPA). Related to the issue of program growth and the decision whether to include a supplemental program application, this study further looked at both the ACT composite and sub-scores of incoming freshmen relative to SGPA at the completion of the program. The purpose of this was to determine whether ACT composite or ACT sub-scores are a better predictor of degree of success among incoming freshmen who complete the program.

Of the 90 total freshmen who entered the program during the relevant time period, 49 did not complete the program. Possible reasons for not completing the program include but are not limited to change of major, change of university, and finances and should not necessarily be interpreted as being related to academic performance. Of the remaining 41 students three did not have all relevant ACT sub-scores available due to a converted SAT score. These students were also removed from consideration which resulted in a sample size of 38 incoming freshmen who had complete ACT sub-scores. In each analysis below the dependent variable was SGPA. The respective independent variables were ACT composite score and the ACT sub-scores of English, Math, Reading and Science. Simple linear regression analysis was performed to assess the correlation between the ACT composite

and sub-scores and the SGPA. As shown in Table 2, below,  $R^2$  estimated the amount of variance in the dependent variable SGPA that was accounted for by the independent variable of ACT composite or sub-score. The ACT composite score accounted for 15.87% of the variance in the SGPA. Based on the correlation coefficient and the modified Pearson correlation coefficient guide, the regression model showed a weak positive relationship between SGPA and ACT composite score. With a p-value of 0.0133, the results are statistically significant, indicating that for problem-based learning, ACT composite score is a weak predictor of SGPA.

Table 2  
*Freshman ACT composite and subject sub-scores v. SGPA*

Type of ACT score v. SGPA	N	RSME	$R^2$	Standardized Coefficients	p-value
Composite	38	0.3877	0.1587	0.3983	0.0133
English	38	0.3865	0.1638	0.4047	0.0117
Math	38	0.3844	0.1728	0.4157	0.0094
Reading	38	0.4048	0.0825	0.2872	0.0804
Science	38	0.3827	0.1800	0.4243	0.0079

The respective  $R^2$  values for the independent variables of ACT English, Math, and Science sub-scores are all higher than the  $R^2$  value for the ACT composite score, with the sub-scores accounting for the 16.38%, 17.28%, and 18.00% of the variance in the SGPA, respectively. Based on the correlation coefficient and the modified Pearson correlation coefficient guide, the respective relationship between SGPA and each sub-score are as follows:

- The regression model for ACT English sub-score showed a moderate positive relationship between SGPA and ACT English sub-score. With a p-value of 0.0117, the results are statistically significant, indicating that for problem-based learning, ACT English sub-score is a moderate predictor of SGPA.
- The regression model for ACT Math sub-score showed a moderate positive relationship between SGPA and ACT Math sub-score. With a p-value of 0.0094, the results are statistically significant, indicating that for problem-based learning, ACT Math sub-score is a moderate predictor of SGPA.
- The regression model for ACT Science sub-score showed a moderate positive relationship between SGPA and ACT Science sub-score. With a p-value of 0.0079, the results are statistically significant, indicating that for problem-based learning, ACT Science sub-score is a moderate predictor of SGPA.
- The independent variable of ACT Reading sub-score had the lowest  $R^2$  value with the variable accounting for 8.25% of the variance in SGPA, and was the only ACT sub-score with a lower  $R^2$  than the independent variable ACT Composite score. The regression model for ACT Reading sub-score showed a weak positive relationship between SGPA and ACT Reading sub-score. With a p-value of 0.0804, the results not statistically significant.

## Conclusion

Based on the results of this study, ACT Composite score is not a reliable predictor of whether a student who begins the problem-based curriculum will complete the degree requirements. This is consistent with the results of a prior study that analyzed the correlation between ACT Composite score and grade point average in problem-based courses (Herrmann, 2020). When limited more narrowly to incoming freshmen who completed the degree requirements, ACT Composite score is a

weak predictor of the degree of success in terms of GPA in the problem-based courses. The ACT sub-scores of Science, Math, and English are moderate predictors of success. These results are consistent with a prior study that found a positive correlation between ACT sub-scores and grade point average (Noble, et al. 2002). While it may be expected that Math and Science sub-scores might be more reliable than the Composite score for construction and engineering-based programs, it is interesting to note that the English sub-score was nearly as reliable as Math and Science, yet English and Reading sub-scores are often less focused on in these disciplines. If the program moves forward with implementing a more selective admission process to control enrollment, these results indicate that ACT sub-scores of Science, Math, and English are more reliable as predictors of success than ACT Composite score. However, due to the small size of this study and since these sub-scores are only moderate predictors of success in problem-based courses, additional criteria should be part of the admission process.

Further studies will explore whether ACT scores are valid predictors of success in the first-year problem-based courses and whether success in those first-year courses is then a valid predictor of success upon completion of the program. These future studies could also be influential if the program moves toward a selective admission process. Additionally, these future studies could potentially reveal whether, or to what extent, the attrition rate may be related to ACT scores as a measure of academic preparedness.

Although very few construction management programs are problem-based to the same extent as the program used for this study, many other programs incorporate problem-based aspects in one or more courses in their curricula. These results may be useful to such programs in making admission decisions. Additionally, as previously noted many colleges and universities across the nation have at least temporarily suspended the requirement that applicants provide standardized test scores as part of the admission application process. These results may also be used by programs to help determine whether to reinstate policies requiring applicants to submit standardized testing scores.

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