Investigating Relationships Between Admission Criteria and Performance in a Construction Management Program

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This work investigates if certain prerequisite requirements or selection criteria are better predictors for student success in an undergraduate Construction Management (CM) program at the University of Washington. Academic records and admission applications of students who graduated from the program from 2014 to 2016 were used as a data set. Authors studied if work experience, cumulative and prerequisite GPA could predict future performance in a CM program. Regression and correlation analysis were performed to determine if these inputs could predict future results. The correlation analysis results indicate that cumulative Grade Point Average (GPA) and GPA on prerequisite courses used for admission criteria have positive correlations with academic success. The regression analysis suggests that the cumulative GPA can be used as a predicative variable for students' academic success in a CM program in a mixed group and transfer students. GPA on prerequisite courses can be a predicator for academic performance in a CM program in non-transfer students.

Introduction

Each year the CM program at the University of Washington (UW), an undergraduate admission committee evaluates various admission criteria to select the most qualified applicants to enter a program to earn a BS in CM. The CM program has adopted a comprehensive approach to the selection process for incoming CM students that uses not only multiple academic criteria but also non-academic criteria.

The CM undergraduate program at the UW is a two-plus-two program where students spend their first two years completing general education and prerequisite requirements. Their last two years focus on CM specific subjects. Students in their second year of college study can apply to the CM department if they meet the prerequisite requirements. The CM department evaluates various admission criteria of the applicants and selects new students to continue the next two years in the CM program. While most applicants are current students of the UW the department also accepts about 20 to 30 percent of the total accepted students from local community colleges.

To ensure student academic and career success, it is important to select most qualified applicants into the CM program. The CM department uses diversified admission criteria, which include the following components: (1) GPA (Total GPA, GPA on pre-requisite courses, and GPA on math and physics), (2) work experience, (3) personal statement, and (4) recommendations. To select the most qualified students, the authors sought to understand which criteria are related to future students' performance in CM course work. This study is different from previous studies that have focused on standardized tests such as SAT scores.

Studies have reported correlations or indices of relationship in the predictive ability of standard exam scores. Previous studies show that the predictive ability of standard exams tend to improve when a particular test matches a specific discipline in such a way that the verbal scores of standard exams is a modest predictor of success in

descriptive disciplines while the quantitative score is a better predictor in quantitative disciplines (Wao et al., 2015). Braunstein (2001) showed that work experience as well as standard exam scores are correlated to their academic performances in MBA program. Wang (2013) investigated the predictive ability of GRE scores on academic performance (GPA) of engineering disciplines. On the other hand, Wao et al (2016) showed that their hypothesis of higher GRE scores being associated with higher success rates at CM graduate programs was not supported.

Though previous studies investigated the relationship between standard exam scores and academic performance after students are admitted, they are not applicable to the UW undergraduate CM program admission since the students' standard tests were already considered at the time of college admission and these do not contain any college level work. In addition, we have two different groups of applicants: non-transfer students and transfer students.

The objective of this paper is to investigate which certain prerequisite requirements or selection criteria are better predictors for student success in a CM program. Part of the rationale to perform the study was a perception that transfers students may not be as academically prepared to succeed and work experience should play a greater role in selection. The authors were also curious if the selection criteria to predict success for transfer students is different than those for non-transfer students.

Data and Research Method

The data consists of admission records and transcripts on recent graduates (2014 to 2016) from our CM undergraduate program. The program accepts both transfer and non-transfer students and these two groups of students have different academic backgrounds. This research performed a separate statistical analysis on each group as well as on a mixed group. The sample size of the mixed group was 98 students (N=98), which consisted of Non-Transfer students (N= 59) and Transfer students (N=39).

The dependent variable, used to measure students' academic success at our CM program is GPA on five core courses (Estimating II, Scheduling, Soils and Foundations, Project Management, and Capstone). The courses were selected because they represent some of the highest level of learning using Bloom's taxonomy or have a technical bias to the course work. The capstone course at UW is an individual effort and is one of our most demanding courses. The independent variables, admission criteria that can be quantified, include cumulative GPA (CUM_GPA), GPA on prerequisite courses (PreReq), GPA on math/physics classes (STEM), and work experience at time of application. The variable of the work experience is measured by the rubric shown in Table 1.

Table 1

Work experience score

Scale	Criteria
0	No work experience
1	Work experience, but not construction related
2	Summer work experience on construction projects (excluding project engineer internship, apprentice/journeyman experiences)
3	Construction related experience either full time less than one year in trades or one summer project engineer internship
4	Construction related experience either full time more than one year in trades or more than one summer project engineer internship

The amount of time and nature of the work experience within the construction industry is of special importance to the admissions committee. For example, three years of summer experience in a non-construction job is scored as a one while one summer work experience on a construction project is evaluated as a two.

The input and output variables used in this study are listed in Tables 2 and 3. Correlation and regression analysis techniques were employed in an examination of the data. The primary goal was to ascertain which of the independent variables are most closely related to the academic success of students in the CM undergraduate program. Of interest were relationships between some of the independent variables used in the analysis.

Table 2

Output variable

Output Variable	Description	Scale
CM_GPA	Academic performance at the CM undergraduate program (GPA earned in: Estimating II, Scheduling, Project Management, Soils and Foundations, and Capstone)	0 to 4

Table 3

Input variables

Input variables	Description	Scale
CUM_GPA	Cumulative GPA at the time of application	0 to 4
PreReq	GPA on the CM department's prerequisite courses	0 to 4
STEM	GPA on math and physics courses	0 to 4
Work_Exp	Level of experience according to the rubric (Table 1)	0 to 4

Data Analysis and Results

Tables 4 to 6 present the number of samples, means, and standard deviations of each variable. Table 4 shows the descriptive statistics on all students including non-transfer students and transfer students; Table 5 shows non-transfer students; and Table 6 shows transfer students. Figure 1 presents the comparison of mean value of each variable for two groups. As seen in Figure 1, the transfer students are likely to have more job-related work experience than the non-transfer students. Also shown in this figure is that the difference between GPA among groups of students is not significant.

Table 4

Descriptive statistics on all samples

Variable	Type	Min	Max	Mean	Standard Deviation	N (Sample Size)
CM_GPA	Dependent	2.1	4	3.2571	0.36552	98
CUM_GPA	Independent	2.36	3.94	3.2801	0.33007	98
PreReq	Independent	2.31	3.95	3.2206	0.30846	98
STEM	Independent	2	4	3.1881	0.45861	98
Work_Exp	Independent	0	4	1.6327	1.14323	98

Table 5

Descriptive Statistics on non-transfer students

Variable	Type	Min	Max	Mean	Std. Deviation	N (Sample Size)
CM_GPA	Dependent	2.18	4	3.3387	0.33113	59
CUM_GPA	Independent	2.67	3.81	3.2437	0.25005	59
PreReq	Independent	2.56	3.74	3.1929	0.25633	59
STEM	Independent	2.53	4	3.2014	0.37698	59
Work_Exp	Independent	0	4	1.2542	0.77889	59

Table 6

Descriptive statistics on non-transfer students

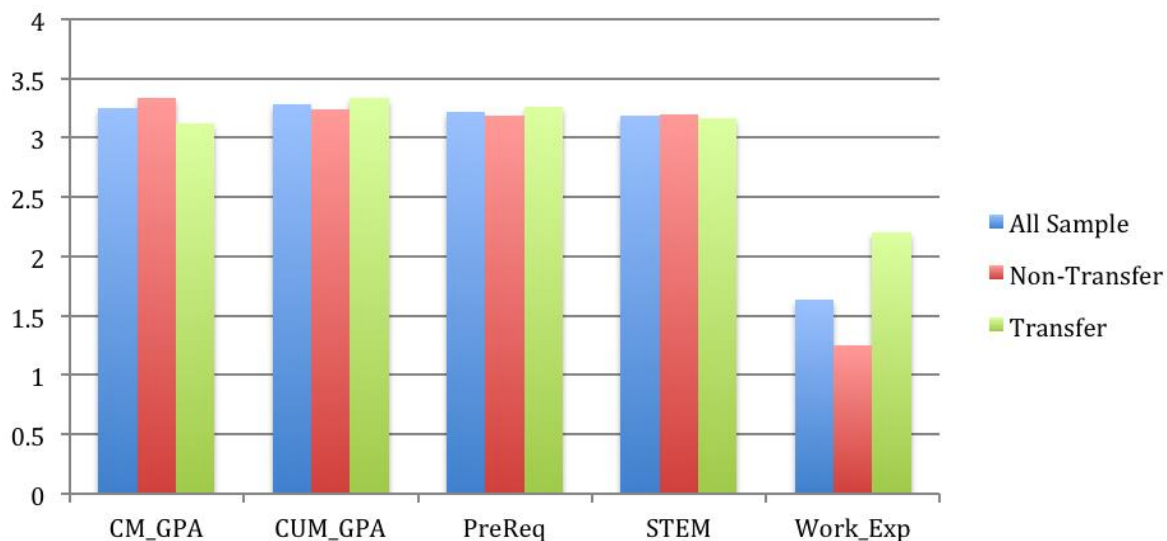| Variable	Type	Min	Max	Mean	Std. Deviation	N (Sample Size)
CM_GPA	Dependent	2.1	3.82	3.1195	0.3655	39
CUM_GPA	Independent	2.36	3.94	3.3351	0.42133	39
PreReq	Independent	2.31	3.95	3.2626	0.37361	39
STEM	Independent	2	4	3.1679	0.56505	39
Work_Exp	Independent	0	4	2.2051	1.36072	39

Figure 1 Comparison of mean value of each variable on two groups

Correlation Test

Tables 7, 8 and 9 show the correlations between independent variables and dependent variables using Pearson's correlation text. In the mixed group and the non-transfer group, two independent variables CUM_GPA (Cumulative GPA at the time of application) and PreReq (GPA on the CM department's prerequisite courses) demonstrated a positive relationship with academic performance in the CM undergraduate program, as shown in Tables 7 and 8.

In the transfer group, only CUM_GPA is shown to have positive relationship with academic performance in the CM undergraduate program as shown in Table 9. It is noted that the correlation coefficient between independent variable (CUM_GPA and PreReq) and dependent variable (CM_GPA) is lower when tested in a mixed group.

Table 7

Correlation coefficient (mixed group)

		CM_GPA	CUM_GPA	PreReq	STEM	Work_Exp
CM_GPA	Pearson Correlation	1				
	Sig. (2-tailed)					
CUM_GPA	Pearson Correlation	0.375**	1			
	Sig. (2-tailed)	0				
PreReq	Pearson Correlation	0.273**	0.651**	1		
	Sig. (2-tailed)	0.007	0			
STEM	Pearson Correlation	0.232*	0.560**	0.811**	1	
	Sig. (2-tailed)	0.021	0	0		
Work_Exp	Pearson Correlation	-0.09	0.004	-0.041	-0.109	1
	Sig. (2-tailed)	0.379	0.969	0.689	0.285	

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 8

Correlation Coefficient (Non-Transfer Students)

		CM_GPA	CUM_GPA	PreReq	STEM	Work_Exp
CM_GPA	Pearson Correlation	1				
	Sig. (2-tailed)					
CUM_GPA	Pearson Correlation	0.460**	1			
	Sig. (2-tailed)	0				
PreReq	Pearson Correlation	0.475**	0.766**	1		
	Sig. (2-tailed)	0	0			
STEM	Pearson Correlation	0.328*	0.644**	0.760**	1	
	Sig. (2-tailed)	0.011	0	0		
Work_Exp	Pearson Correlation	0.051	-0.142	-0.132	-0.211	1
	Sig. (2-tailed)	0.702	0.283	0.317	0.108	

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 9.

Correlation coefficient (transfer students)

		CM_GPA	CUM_GPA	PreReq	STEM	Work_Exp
CM_GPA	Pearson Correlation	1				
	Sig. (2-tailed)					
CUM_GPA	Pearson Correlation	0.447**	1			
	Sig. (2-tailed)	0				
PreReq	Pearson Correlation	0.186	0.574**	1		
	Sig. (2-tailed)	0.257	0			
STEM	Pearson Correlation	0.149	0.528**	0.863**	1	
	Sig. (2-tailed)	0.365	0.001	0		
Work_Exp	Pearson Correlation	0.036	-0.013	-0.074	-0.041	1
	Sig. (2-tailed)	0.827	0.936	0.656	0.803	

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Regression Analysis

The correlation analysis shows the relationship between input and output variables. A regression analysis was also performed to further analyze the relationships between admission criteria and academic performance in the CM program. The authors tested two different methods to identify relationships between admission criteria and earned academic performance within the CM program: (1) multi-regression method and (2) step-wise regression method. A step-wise regression method was adopted in which the forward and backward look step-wise method was revised to include only the input variables that were significant in the models (i.e. $p < 0.05$) (Makridakis et al, 2008).

The results of the analysis are shown in Tables 10 through 12. Each table for each group includes one significant input variable along with excluded variables. In the mixed group, as shown in Table 10, a variable of CUM_GPA is significantly related to the students' academic performance at the CM program, explaining 14.1% of the data. In the group of non-transfer students, a variable of PreReq is shown to be a significant input variable related to the student's academic performance in the CM program as shown in Table 11. The regression model for non-transfer students explains 22.5% of the data. In a group of transfer students, a variable of CUM_GPA is significantly related to the students' academic performance at the CM program, explaining 20% of the data.

Table 10.

Stepwise Regression Analysis Result (Mixed Group)

Number of Observations = 98

Dependent Variable = CM_GPA

Adjusted R-Squared = 0.141

	Coefficient	Standard Error	Sig
CUM_GPA	1.896	0.345	0.007

Excluded Variables	Coefficient	Sig	
PreReq	0.05	0.692	
STEM	0.033	0.775	
Work_Exp	-0.091	0.337	

Table 11

Stepwise regression analysis result (non-transfer students)

Number of Observations = 59

Dependent Variable = CM_GPA

Adjusted R-Squared = 0.225

	Coefficient	Standard Error	Sig
PreReq	0.627	0.154	<0.01

Excluded Variables	Coefficient	Sig	
CUM_GPA	0.234	0.2	
STEM	-0.078	0.669	
Work_Exp	0.116	0.329	

Table 12

Stepwise Regression Analysis Result (Transfer Students)

Number of Observations = 39

Dependent Variable =CM_GPA

Adjusted R-Squared = 0.200

	Coefficient	Standard Error	Sig
CUM_GPA	0.388	0.128	0.004

Excluded Variables	Coefficient	Sig	
PreReq	-0.105	0.565	
STEM	-0.12	0.494	
Work_Exp	0.042	0.779	

Discussion and Conclusion

This research investigated the relationship between admission criteria and student's academic success at the UW CM program. The research used data from recent graduates (N=98) that consisted of non-transfer students (N=59) and transfer students (N=39). The objective was to see if certain selection criteria are indicative of a student's success in a CM program (high GPA in a certain set of classes).

The correlation analysis results indicate that cumulative GPA and GPA on the prerequisite courses portion of admission criteria do have the strongest positive correlations with academic success as measured by GPA on a select

group of core CM courses in a mixed group (transfer and non-transfer) and non-transfer students. The results also show that the cumulative GPA is the only admission criterion that has the positive correlation with academic success for transfer students. Although seemingly obvious GPA does tend to predict future success. The perception that work experience predicted future academic success did not predict future success. It was found that the correlation coefficient between work experience and academic success is non-existent. Though job-related work experience is considered to help students understand the course materials taught in most construction management core courses, it turned out that they did not have significant correlation with academic performance measured by GPA in a CM program.

The stepwise regression analysis results suggest that the cumulative GPA part of admission criteria can be used as a predictive variable for student's academic success in a CM program in a mixed group and transfer students. The analysis also shows GPA on prerequisite courses can be a predicator for academic performance for transfer students in a construction management program. However, the regression model is hard to apply to predicting students' future GPA due to R-square value being low.

The results of both the correlation and regression tests shows that the correlation coefficient and R-square value drop when comparing a mixed group to those in a separate group (i.e., transfer students and non-transfer students). It suggests that the admission criteria for transfer students be different than that on non-transfer students.

Recommendations

The results suggest using the criteria established for determining admission in the CM program, rely on a heavy emphasis on cumulative and prerequisite GPA. Programs may want to rely less on work experience as an admission criteria to ensure the highest academic success.

Future studies may want to investigate if high academic success, high graduation GPA, correlates to high career success.

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