Impact of Mathematics and Physics Grade Point Averages on the Overall GPA for Construction Management Undergraduate Students

Pramen P. SHRESTHA & Nirajan MANI
Civil and Environmental Engineering Department, Howard R. Hughes College of Engineering
University Of Nevada Las Vegas
Las Vegas, Nevada, 89154, USA

ABSTRACT

The performance of Construction Management (CM) students in their undergraduate studies is believed to be dependent on their mathematics and physics performance. The overall performance of students is measured by their overall Grade Point Average (GPA) for this study. Similarly, the performance of students in mathematics and physics are measured by the respective GPAs in these subjects. This study analyses the correlation of the mathematics and physics GPAs with the overall GPA. The study includes data of CM students who graduated between 1982 and 2010 from the University of Nevada, Las Vegas (UNLV). The research hypothesis for this study is that there is a significant correlation between the overall GPA with the mathematics and physics GPAs of CM undergraduate students. The statistical test results showed that there is a statistically significant correlation between the overall GPA with the mathematics and physics GPAs.

Keywords: Mathematics, Physics, Construction Management, Undergraduate Study, Grade Point Average.

1. INTRODUCTION

American Council for Construction Education (ACCE) requires that construction management undergraduate students in accredited programs take a minimum of 15 semester credit hours of mathematics and science courses. In addition to this, these students should take a minimum of 20 semester credit hours in construction science and a minimum of 20 semester hours in construction. A minimum aggregate of both construction science and construction combined of 50 semester credit hours requires as per ACCE.

It is believed that construction science courses require a significantly higher level of knowledge, skill, and ability in mathematics and physics than do the construction courses. Therefore, students must perform well in mathematics and physics courses to perform satisfactorily in construction science courses. It is also believed that students must perform equally well in construction science and construction courses to develop the level of knowledge, skills and abilities that are critical to becoming a successful professional in the construction industry. It is obvious that the overall grade point average (GPA) of the students directly depends upon all of these courses; in other words, the higher the grade in all courses, higher the overall GPA. The University of Nevada, Las Vegas (UNLV) Construction Management program places an emphasis on ensuring that students take the necessary mathematics and physics courses so that they are able to successfully apply these courses' fundamental concepts in construction science and construction courses.

The majority of the Construction Management (CM) undergraduate students at the University of Nevada, Las Vegas (UNLV) are having difficulty in passing the mathematics and physics courses required by the ACCE. This is impacting the graduation rate; also, students are having problems passing the construction science and construction courses at UNLV. It is assumed that the lack of knowledge in mathematics and physics is affecting the GPAs of these courses and ultimately affecting the overall GPA of these students. To determine whether there is a relationship between mathematics and physics GPAs with overall GPA, data was collected of CM students who passed these courses and graduated in last 10 years. The results of this study will shed some lights on this issue.

2. HYPOTHESES

Research Hypotheses

The variables considered for this study are the mathematics GPA, the physics GPA, and the overall GPA at graduation. Two research hypotheses for this study were formulated, as shown in Table 1.

Table 1. Research Hypotheses.

Hypothesis No.	Research Hypotheses (H_a)
H_a1	A higher GPA in mathematics will result in higher overall graduation GPA of Construction Management students.
H_a2	A higher GPA in physics will result in higher overall graduation GPA of Construction Management students.

Null Hypotheses

The above research hypotheses are converted to null hypotheses to conduct the statistical test, as described in Table 2. The statistical test hypothesizes that the correlation coefficient between these variables is not significantly different from zero. Mathematically, it can be expressed as:

$$\beta_1 = \beta_2 = 0$$

Table 2. Null Hypotheses.

Hypothesis No.	Null Hypotheses (H_o)
H_o1	There is no relationship between the mathematics GPA and the overall graduation GPA of the Construction Management students.
H_o2	There is no relationship between the physics GPA and the overall graduation GPA of the Construction Management students.

For the null hypothesis to be false, the p-value must be less than or equal to 0.05. Given that the null hypothesis is true, the p-value represents the probability of observing a test statistic that is at least as large as the one that is actually observed.

3. LITERATURE REVIEW

Several studies have been conducted to determine the factors that have significant effects on students' academic performance. These studies have found that student characteristics, teaching effectiveness, gender, academic classification, performance in prerequisite courses, and overall academic ability play significant roles in the performance of students [4, 6, 8, 9].

Choudhury (2001) conducted a research to determine the factors that affect the student's performance in Environmental Control Systems Courses at the undergraduate level in the Department of Construction Science at a large university in the south central region of the United States. Ten factors were considered for the analysis. The population collected for the study consisted of the 223 students who attended such courses during the Summer Semesters of 1997 and 1998, the Fall Semester of 1997, and the Spring Semester of 1998. The multiple regression analysis showed that such courses are not correlated with class size. Personal characteristic variables, such as gender and academic classification, are inversely related to student performance. The study found that the overall academic ability of a student is positively correlated with student performance. The F-test that was conducted was found to be statistically significant at the 0.0001 level. The R-square value of the model was found to be 0.37. From the multiple regression analysis, the following model was developed:

$$GRADE = 62.48 + 0.05 * CLSIZE + 0.95 * SEMESTER - 2.04 * SEX - 2.3 * LEVEL + 0.64 * INSPIRE + 0.24 * FEELING - 0.93 * CONTRIB + 0.21 * UNDSTAND + 0.5 * SATISFY + 5.36 * GPA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

A study by Meltzer (2002) was conducted to determine the relationship between mathematics preparation and conceptual learning gains in physics [1]. Students' conceptual knowledge was assessed by administering a diagnostic test on physics concepts during the first and last days of class. The authors collected the data of students enrolled in Fall 1997 and Spring 1998 physics courses of Southeastern Louisiana University (SLU) and Fall 1998 and Fall 1999 physics courses of Iowa State University (ISU). These physics courses covered electricity and magnetism, including direct current circuits. The sample size for these courses offered at SLU was 45 and 37, respectively. For the courses offered in ISU, the sample size was 59 and 78, respectively. The authors found that student's normalized learning gains were not significantly correlated with their pre-test scores on a physics concepts test. However, the normalized learning gain was significantly correlated with mathematics pretest scores in a sample of one LSU physics course and two ISU physics courses.

Sidiropoulos et al. (2005) in investigating the factors that contribute to student success, provided new ideas on how these factors could be used to offer adaptive learning in studying economics in a web based environment [3]. The authors collected data from 200 students enrolled in economics and finance classes in the department of Applied Informatics at the University of Macedonia, Greece. The data collected included family condition and education, sex, age, GPA, previous knowledge in mathematics, and previous knowledge about computers and the internet. This study showed that girls gained significant higher marks than boys in the economics module. The study also found that the father's education

was a strong indicator of student success with the module. Students having more educated fathers (M.Sc. or Ph.D.) gained better marks in the module than other students. Finally, the research showed that students with overall high GPAs scored high marks in economic lessons.

Choudhury (2002) conducted research to examine the effects of overall academic capability of students on their performance in this course [5]. The overall academic capability of a student was measured by GPA. The sample size for this study was 329, taken from a population of students who attended Environmental Control System courses in Fall, Spring, and Summer semesters from 1997 through 2001. A simple linear regression technique was used to predict the following model:

$$GRADE = 10.76 + 37.15 * GPA - 4.17 * GPASQ + 2.08 * MAJOR \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, GRADE = student performance in terms of numerical grade, GPA = grade point average of a student, GPASQ = quadratic term of GPA, MAJOR = academic major of a student.

The research found that overall academic capability and the major of a student both have statistically significant effects on the student performance in the Environmental Control Systems courses. The R-square value for the model was found to be 0.59. This model could be helpful to the instructors to formulate teaching strategies.

A study was conducted by Orth (2004) to identify variables that could serve as predictors of student retention and success in an undergraduate construction management program [2]. The independent variables in this study were high school rank, high school GPA, high school class size, the number of high school science courses, the number of high school mathematics courses, the SAT composite score, matriculation age, gender, race, and residence. Data was collected from 343 students enrolled from Fall 1992 to Fall 1997 in the Building Science Department at Purdue University. A logistic regression model was developed, and the relationship was tested at the 0.05 significance level. The Wild Chi-Square test showed that the high school GPA and the number of high school mathematics courses taken with regard to graduating the Construction Management (CM) program were found to be statistically significant at $\alpha = 0.05$. These results showed that the students who have taken significant number of mathematics courses in high school also have a high graduation rate in the CM program. This indicated that a solid mathematics education is vital for Construction Management students to graduate from this program.

Shrestha and Shields (2009) found that the GPA of undergraduate students in Construction Science course is directly correlated with the GPA of the mathematics courses taken at the university level. They found a significant correlation between the mathematics GPA and the final test score of the students in this course. However, no significant correlation was found between the physics GPA and the final test score of this course. A multiple regression model was created to predict the final test score of CM students in this course using mathematics and physics as input variables; it was found to be not significant [7].

4. METHODOLOGY

The methodology of this study consisted of five steps. The first step was to perform a literature review to determine whether any other studies have been conducted relating to these hypotheses: 1) better performance in mathematics results in a higher overall GPA for undergraduate CM students; and 2) better performance in physics results in a higher overall GPA for undergraduate CM students.

The second step of the study was to collect the mathematics and physics grades as well as the overall GPA data for undergraduate CM students. Then correlation tests were conducted between the mathematics and physics GPAs with regard to the overall GPA. If a significant correlation was found between the mathematics and physics GPAs with regard to the overall GPA, then the final step of the study was to develop a multiple regression model that could predict the overall GPA by using the mathematics and physics GPAs as input variables.

These five steps were followed by an exploration of the data collected and also a discussion of the implications of this research. At the end of this paper, conclusions and recommendations for future research areas will be discussed.

5. DATA DESCRIPTION

The data of CM students who graduated from UNLV between 1982 to 2010 were collected randomly. These data were obtained from the Office of Undergraduate Advising at UNLV. In the data analysis, only students who had taken mathematics and physics courses at the university level were considered. According to ACCE accreditation, CM students had to take at least two mathematics and two physics courses. The grade point average of the mathematics and physics courses was calculated for each student to use in the analysis. The total sample size for the analysis was 77. Both a linear correlation analysis and a multiple regression analysis

were conducted to determine the significant relationship between overall GPA with the mathematics and physics GPAs of the students.

6. RESULTS

Once the data was collected, it was entered into a Statistical Package for Social Sciences (SPSS) for processing. The descriptive data analysis shows that the mean for the overall grade, the mathematics grade, and the physics grade was 3.04, 2.86, and 2.69, respectively. The mean and median are very close to each other. The low standard deviation value showed that there is a small variation in the data set.

Variables (GPA)	No. of Sample	Descriptive Statistics		
		Mean	Median	Standard Deviation
Overall Grade	77	3.04	3.03	0.35
Mathematics Grade	77	2.86	2.85	0.50
Physics Grade	77	2.69	2.65	0.59

A Pearson Correlation test was conducted to determine the correlation coefficient between the overall GPA with mathematics and physics GPAs. Before conducting this test, the data were tested for normality. The histograms were plotted for these data, and showed that data for the overall, mathematics, and physics GPAs were normally distributed. Figure 1 shows the histograms of the overall, mathematics, and physics GPAs of CM students.

Table 3. Descriptive statistics of overall, mathematics, and physics grade point averages.

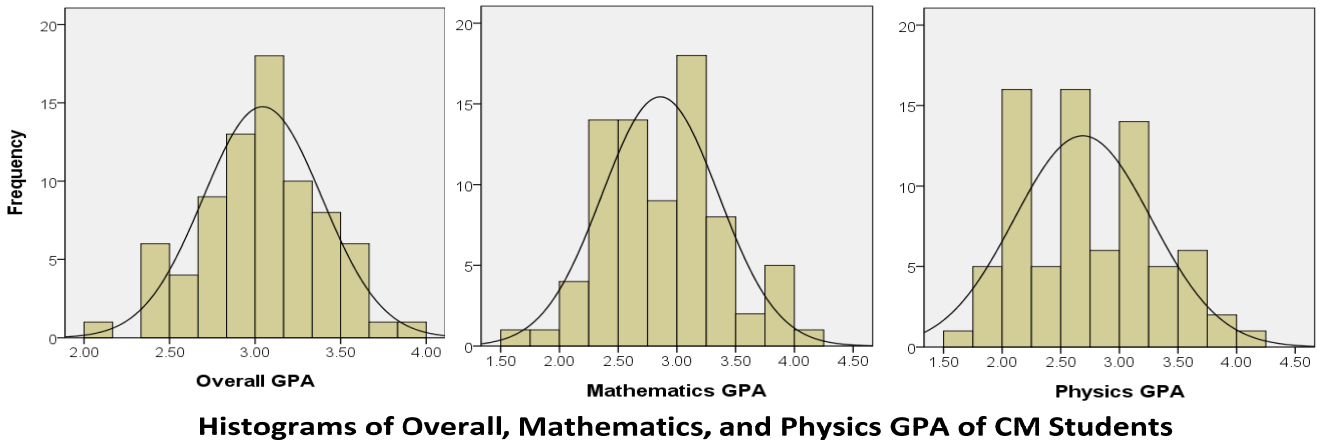

Fig. 1. Histogram of overall, mathematics, and physics GPAs.

Since histograms for mathematics GPA and Physics GPA curves do not show normal distribution, the Anderson-Darling test was conducted to check the normality of these variables. The null hypothesis of this test was that the data is normally distributed. If the p value was less than 0.05, then it would reject the null hypothesis. Table 4 shows the result of Anderson-Darling test, which indicated that all three variables are normally distributed.

Table 4. Anderson Darling Normality Test Results.

Variables	No. of Sample	p value	Remarks
Overall GPA	77	0.507	Normally distributed
Mathematics GPA	77	0.243	Normally distributed
Physics GPA	77	0.055	Normally distributed

The results of this analysis, presented in Table 5, indicate that there is a statistically significant relationship between

the overall GPA with the mathematics and physics GPAs. The correlation between the overall GPA and the mathematics GPA was found to be 0.497, and the correlation between the overall GPA and the physics GPA was found to be 0.503. These correlations were significant at alpha level 0.01. This also indicates that the relationships are positive, which indicates that the increase in mathematics and physics GPAs results in an increased overall GPA for CM students.

Table 5. Pearson Correlation test results.

Variables	No. of Sample	Pearson Correlation Coefficient	p value
Correlation with the Overall GPA			
Mathematics GPA	77	0.497**	<0.01
Physics GPA	77	0.503**	<0.01

** Significant at alpha level 0.01 (2-tailed)

Figure 2 shows the scatter plot of the overall GPA versus the mathematics GPA, and Figure 3 shows the scatter plot of the overall GPA versus the physics GPA. These graphs show that there is positive relationship between these variables.

The high correlation between these two variables suggests that a linear regression model can be developed to predict the overall GPA with the mathematics and physics GPAs of the students. Therefore, a multiple regression model was developed using the overall GPA as a dependent variable and the mathematics and physics GPAs as independent variables. The R-square value for the model was 0.247. Also, the model is statistically significant at alpha level 0.001. Equation (3) shows the regression model that predicts the overall GPA of CM students.

$$Overall\ GPA = 0.319\,x\,Mathematics\ GPA + 0.275\,x\,Physics\ GPA + 1.393 \quad ....(3)$$

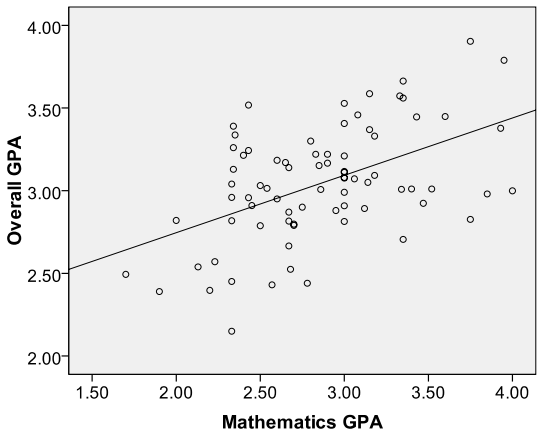

Fig. 2. Scatter plot of the overall GPA versus the mathematics GPA.

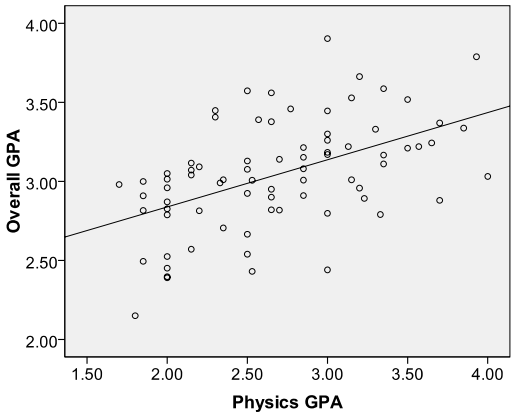

Fig. 3. Scatter plot of the overall GPA versus the physics GPA

7. CONCLUSIONS AND RECOMMENDATIONS

This study tested two major hypotheses. The first hypotheses, related to relationship between the overall GPA and the mathematics GPA, was proved to be true for this sample. The result showed that the better mathematics GPA is, the better the overall GPA of the CM students will be.

The second hypothesis states that there is a correlation between the overall GPA and the physics GPA, which also was found to be true for this sample. It indicates that the higher the GPA in physics, the higher the overall grade of CM students will be.

The CM students at UNLV take minimum of 15 credit hours of mathematics and physics courses before they start taking construction science courses. The number of credit hours taken in these two subjects is very low in compared to the credit hours taken in construction science and construction courses. Therefore the effect of mathematics and physics GPAs in the overall GPA is very small in comparison to the GPAs of other courses. However, this study results showed that the impact of the physics and mathematics courses on their overall GPA was very high and significant.

The findings of this research shed some light on how important it is for undergraduate students to perform well in mathematics and physics in order to achieve a higher overall GPA in the CM undergraduate program. It is recommended that further study be conducted to determine the impact of class size, instructor ability, types of instruction, gender, teaching effectiveness, and factors regarding undergraduate construction management subjects in order to determine the impact on the overall GPA.

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