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Relating grades of maths and science courses with students' performance in a multi-disciplinary engineering program – a gender inclusive case study

A. Imran*, M. Nasor, F. Hayati

Ajman University of Science & Technology, PO Box 346, Ajman, UAE.

Abstract

Statistical analysis was used to evaluate relationships between students' overall and course performances in a multi-disciplinary undergraduate engineering program. 319 students admitted during 1999–2009 were considered. 6 courses in mathematics, 4 in physical-sciences and 3 in life-sciences were analyzed.The difference between program and course performances was less than ±0.5 grade point average for 75%, 63% and 58% students, respectively, in mathematics, physical-sciences and life-sciences. Respective coefficients of correlation were 0.85, 0.76 and 0.79. The women sub-group achieved closer relationships.The analysis suggests that performance in mathematics courses could indicate the trend toward overall performance in the engineering program.

Keywords: Performance in engineering programs, maths and science grades, gender in engineering, multi-disciplinary engineering program;

1. Introduction

Biomedical engineering (BME) is a multi-disciplinary field of study and in the recent two decades or so, undergraduate programs in this field have gained significant importance globally. Such multi-disciplinary programs train students to develop and apply knowledge as well as skills of basic science and engineering to several physiological aspects of the human body. Though the programs may have different emphases, the curricula components, in general, include mathematics, physical sciences, life sciences, basic engineering, biomedical engineering and general studies (Whitaker). Also, in such multi-disciplinary programs enrollment is open for students from a variety of academic backgrounds in science, engineering and medicine. Therefore, students' performance in the biomedical engineering programs may vary significantly.

Several studies have been conducted to investigate the influence of various factors on university students' performance (Imran *et al.*, 2011(a, b); Imran *et al.*, 2010; Nasor *et al.*, 2011; Howe, *et al.*, 2010; Madsen & Ingram, 2010; Madsen *et al.*, 2010; Ali & Ali, 2010; Cohen, 1946). However, there is a lack of such studies in the field of

* Ahmed Imran. Tel.: ++971-50-2850131
E-mail address: ajac.ai_imran@ajman.ac.ae or ai_imran@yahoo.com

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engineering, particularly for biomedical engineering / bioengineering. Hence, there is a need to evaluate students' performance in BME programs and to determine the factors that may influence performance.

In the present study, ten year data of students' grades in mathematics and science courses was analyzed for their relationship with the overall performance in an undergraduate BME program offered at Ajman University of Science and Technology. The program is accredited with the Commission for Academic Accreditation, U.A.E.

2. Methods

Grade data of 319 students was used. The group is comprised of 174 women and 145 men students admitted to the B.Sc. (Biomedical Engineering) program during the years 1999 and 2009. All of these students satisfied the program eligibility criteria for admission and most of them either graduated or were in their senior level. The data was collected from multiple campuses; with students from various cultural and academic backgrounds (science stream). Each course was taught by more than one teacher during the selected period.

Students' performance was classified into three categories of courses as follows:
Category 1: 6 courses in mathematics (including statistics),
Category 2: 4 courses in physical sciences, and
Category 3: 3 courses in life sciences.

Cumulative Grade Point Average (CGPA) was used to measure overall performance in the program.

The study group included only those students who had completed a minimum of 45 credit hours in the program as well as had enrolled for at least 2 courses in each, mathematics, physics, chemistry and life sciences.

For each student, grade point average was calculated separately for each category of courses (GPA-*course*) using the same formula as that for CGPA calculation. For example, GPA-*Maths* was calculated utilizing grades in the 6 mathematics courses. Similarly, GPA-*Physical Sc*. and GPA-*Life Sc*. were also calculated. This allowed direct comparison between overall performance in the program and performance in each course category.

For each student, the difference (D) between CGPA and GPA-*course* was calculated. The percentage of students for whom the value of D was within ±0.5 grade point average was presented (0.5 grade point in a course makes a difference of one grade). Coefficient of correlation (r) between the CGPA and GPA-*course* was also calculated.

In addition to the total group students, the data was also analyzed for the following sub-groups of students: men, women and graduate (or expected to graduate).

3. Results

For each course category, table 1 gives the percentage of students with ($-0.5 < D < +0.5$) for the total, men, women and graduate groups of students.

For each course category, table 2 gives the coefficients of correlation for the total, men, women and graduate groups of students.

Figure 1 shows the variation of CGPA with GPA-*Maths* for total students. In the plot, a straight line is fitted using the method of least squares.

Table 1. Percentage of students with (–0.5 < D < +0.5)

Course Category	Total	Men	Women	Graduate
Mathematics	74.6	73.1	75.9	77.0
Physical Science	63.3	57.9	67.8	60.9
Life Science	58	51.0	63.8	60.8

Table 2. Coefficients of correlation

Course Category	Total	Men	Women	Graduate
Mathematics	0.85	0.81	0.86	0.83
Physical Science	0.76	0.70	0.77	0.75
Life Science	0.79	0.74	0.80	0.78

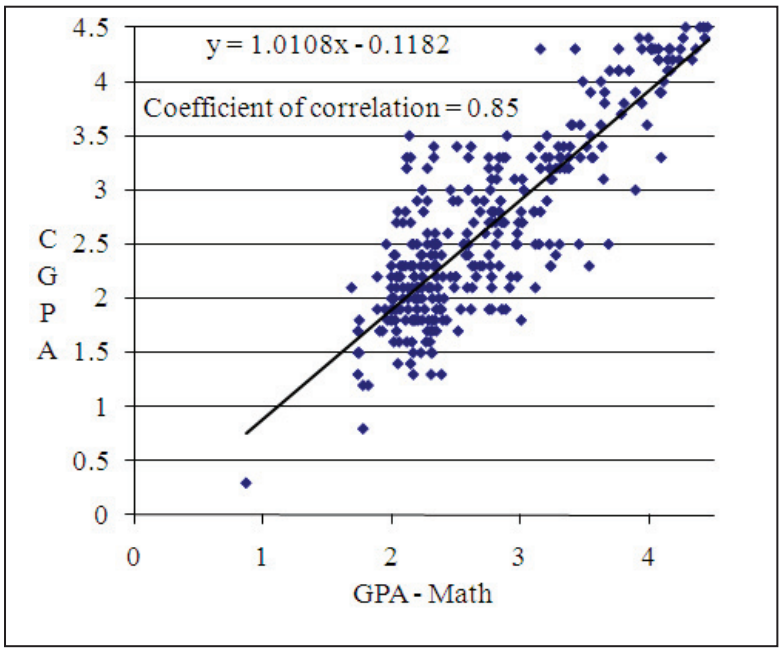

Figure 1. Variation of CGPA with GPA-*Maths* (Total group)

4. Analysis

From table 1, nearly 75%, 63% and 58% students had their CGPA within ±0.5 grade point average of GPA-*Math*, GPA-*Physical Sc*. and GPA-*Life Sc*., respectively. Compared to the men, the women as well as the graduate sub-groups had a higher percentage of students in each course category . In the graduate sub-group, there was higher percentage of students in the mathematics category. Further, for each sub-group of students, the highest and lowest percentages were for the mathematics and life science categories, respectively.

From table 2, the coefficient of correlation between CGPA and GPA-*course* for the total group of students was highest (0.85) for the mathematics courses and lowest (0.76) for the physical science courses. In comparison to the total group, the three sub-groups showed similar patterns. The highest difference from the total was for the men sub-group in each course category.

In figure 1, the straight line fitted using the method of least squares shows nearly 1:1 relationship between the two variables (r = 0.85). This suggests a close relationship between CGPA and GPA-*Math*.

It is also important to note here that although, there were more courses of physical science and life science taken together, the relationship of CGPA was clearly more related to the mathematics courses for the total as well as for each sub-group.

5. Conclusions

The analysis shows that there is a close relationship between students' overall performance in the program and their performance in the mathematics, physical science and life science courses. This relationship is relatively stronger for the mathematics courses compared to that for the physical or life science courses.

The sub-group of women students achieved closer relationship between the compared variables. Further, the values for the graduate sub-group were similar to those for the total group.

Therefore, the analysis suggests that students' performance in mathematics courses could indicate the trend toward overall performance in the biomedical engineering program. Further investigation of factors that influence students' performance is recommended for such multi-disciplinary programs like biomedical engineering / bioengineering in which there is a variety in program emphasis.

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