Factors Predicting the Performance of Engineering Students: A Case Study from Yeditepe University

Deniz Rende¹, Sevinç Rende², and Nihat Baysal³

Abstract - The relationship between the precollege profile of engineering students and their cumulative grade point average (CGPA) in a Turkish private university is investigated in the present study. A dataset including information on student background and scores in university entrance exams for the last four years is used. The models used in this work are selected primarily to examine the relationship between CGPA and the ranking in the university entrance exam. Other factors of interest are attendance to university provided language prep school, scholarship status and gender of the student, and the type and the region of the high school the student had graduated. The results show that ranking in college entrance exams is a statistically significant predictor of college GPA. All else equal, the results also suggest that girls are more successful than boys. Another result of this research is the association between scholarship status and CGPA. The source of tuition scholarship arises as a significant predictor of CGPA as much as the student’s tuition status. One unexpected result of this study is the importance of regional background of the student. Freshman engineering students from other regions do not perform as well as freshman students who attended regional high schools. In time, this discrepancy disappears, but not completely.

Index Terms - Performance predictor, GPA analysis, university entrance exam.

INTRODUCTION

This study aims to investigate the correlation between background information of the engineering students and their academic performances in Yeditepe University, Istanbul, Turkey. For this purpose, we use a novel dataset including information on the student’s GPA, credits taken at the college, as well as university entrance exam performance, high school and regional background of the student. Our results reveal that female students are more successful than male students, regional background of the student matters, and type of the loan the student receives can be important. University entrance exam and high school GPA appear as crucial predictors of success of engineering students. To the best of our knowledge, there is no such statistical analysis based on students’ college GPAs in Turkey. The outcomes of this work can be used to decide new policies on scholarship distribution, curriculum modifications and even the type and contents of the university entrance exam required for college attendance.

The paper consists of six sections. In the next section, we briefly describe the procedure of university entrance exams in Turkey. We follow with a brief explanation of the background case study, namely, Yeditepe University and its engineering faculty. After reviewing the relevant literature, we first analyze the determinants of success of freshman students. We then extend our analysis to all students attending engineering faculty. The last section concludes the paper.

I. University Admission Procedures in Turkey

Anyone wishing to enroll in any undergraduate program of the universities in Turkey must take “The Student Selection Examination (ÖSS)”, held by a governmental organization, “The Student Selection and Placement Center (ÖSYM)”. ÖSS is administered once a year, throughout the country at a single session and at the same time in all centers. ÖSS comprises two tests: One is to measure mainly the candidates’ verbal abilities, and the other, their quantitative abilities. The total time allowed for the two tests is three hours.

In selection and placement decisions, composite scores are used. Firstly, each candidate’s verbal and quantitative raw scores are transformed to standard T scores (a score scale with an arithmetic mean of 50 and standard deviation of 10). Following this, each candidate’s high school grade point average is also transformed to a standard T score in order to achieve uniformity in the units of measurements to be weighted. The arithmetic mean and standard deviation used for this purpose are calculated from the grade point average distribution of the high school the candidate had attended. The last calculation is thought to serve a dual purpose: To minimize the discrepancies that may arise because of the differences in grading between schools, and to counterbalance, to a certain extent, the differences between schools in the resources for effective learning. Final score of the entire exam is the summation of these two scores [1].

The aim of the central placement is to place the candidates in the higher education programs highest on their list of preferences, as is compatible with their scores. Three factors are considered in the placement of students in higher education programs: (a) The quota for each program, (b) The rank of the scores of candidates wishing to enter the same program, (c) The candidates’ list and ranking of these programs. Each candidate can be placed in one program only.

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II. Yeditepe University as a Case Study

Yeditepe University is a private university owned by a non-profit foundation as stated by the law and is under the supervision of Higher Education Council of Turkey. Established in 1996, the university currently has 11 faculties with 52 departments. The student population is approximately 15,000 students and 13% of these students, attend to the Faculty of Engineering and Architecture. The faculty consists of seven engineering departments; Departments of Biomedical, Chemical, Computer, Electrical and Electronics, Mechanical and Systems Engineering along with the Department of Genetics and Bioengineering. Number of students per faculty is about 20. The medium of instruction in the faculty is English and students have to pass an English Proficiency exam (TOEFL-equivalent) in order to attend the classes. Students who fail this exam are required to attend university provided foreign language preparatory school. The duration of the engineering education is four years (eight semesters) and minimum graduation requirements are the successful completion of about 145 credits (~50 courses) with a cumulative grade point average of 2.00 over 4.00.

BACKGROUND LITERATURE

The studies focusing on the US college education system point to various types of predictors of academic performance; SAT math score, SAT verbal score, high school GPA, gender, ethnicity, citizenship status, geographic location and type of the high school [2]. In most of the studies, freshman GPA (FGPA) is accepted as the major indicator for academic success due to the fact that students take similar basic science courses in their first year. Therefore the dataset under study becomes more comparable [3]. Besides, the graduation and retention status is also accepted as a success criteria. In a study performed for engineering students in six universities in United States, it was revealed that for these students, high school GPA and SAT math score was a good predictor for graduation and retention, whereas the SAT verbal score was negatively correlated with the graduation status. Also, the study concluded that, gender, SAT verbal score, ethnicity and citizenship status are strongly correlated with retention but they do not appear significant for graduation [4]. The high school level characteristics are also examined in these studies. The high school average SAT, despite its association with the school demographic characteristics, contains much of the information needed for predicting FGPA's [5]-[6].

ANALYSIS

In this study, we consider two different outcomes relevant for the engineering students of Yeditepe University. The first outcome we are interested is related to the student GPA during the first year at the college. For this purpose, we will use data collected from freshman class for the engineering students who were admitted between years 2002 and 2005. The second outcome we would like to investigate is student GPAs during their studies at the college. Specifically, we would like to understand whether university entrance exams are good predictors of student success at college, and whether student scholarship type exerts any effect on student GPA. Additional concerns that we will address in this study are whether the gender and regional background of the student matter in engineering education.

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**Table I**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGPA</td>
<td>Cumulative Grade Point Average</td>
</tr>
<tr>
<td>FGPA</td>
<td>Freshman Cumulative Grade Point Average</td>
</tr>
<tr>
<td>Gender</td>
<td>0 – Female, 1 – Male</td>
</tr>
<tr>
<td>HSGPA</td>
<td>High School Grade Point Average</td>
</tr>
<tr>
<td>HS Type</td>
<td>High School Type (Public vs. Private)</td>
</tr>
<tr>
<td>TimeGap</td>
<td>If the student has a time gap between the registration to the university and to the faculty courses by means of English Preparatory School or Leave-of-Absence</td>
</tr>
<tr>
<td>Waiver</td>
<td>0 – None, 1 – Yes (The continuity of all scholarship strongly depends on the academic performance)</td>
</tr>
<tr>
<td>Waiver Type</td>
<td>Type of the Tuition Waiver the student receives: 0 – NO_Waiver: If the student pays tuition by her/his own financial sources 1 – GOV_Waiver: As a regulation by law, universities governed by foundations should support a certain percentage of students, who have high scores in university entrance exam, as a tuition waiver. But, the continuity of all scholarship strongly depends on the academic performance 2 – UNI_Waiver: The foundation may support some students with a partial tuition waiver (continuing studies grant), regardless of their university entrance exam rankings</td>
</tr>
<tr>
<td>Rank</td>
<td>University Entrance Exam rank</td>
</tr>
<tr>
<td>Region</td>
<td>Marmara, Aegean, Mediterranean, Central Anatolia, Black Sea, East and Southeast.</td>
</tr>
</tbody>
</table>

**Table II**

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<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGPA</td>
<td>1.961</td>
<td>0.949</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Gender</td>
<td>0.728</td>
<td>0.445</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Waiver</td>
<td>0.428</td>
<td>0.495</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TimeGap</td>
<td>0.722</td>
<td>0.448</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HSGPA</td>
<td>4.094</td>
<td>0.929</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>HS Type</td>
<td>0.330</td>
<td>0.470</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HS Science</td>
<td>0.141</td>
<td>0.348</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Rank</td>
<td>47440</td>
<td>37024.169</td>
<td>662</td>
<td>199616</td>
</tr>
</tbody>
</table>

I. Freshman Class

Table II describes the sample statistics of the dataset representing the freshman class who were placed into the engineering departments between 2002 and 2005. The sample consists of 992 records. Regarding the FGPA, the latest record for cumulative GPA was taken into account. The average FGPA of the sample is 1.961. The average student high school GPA in the sample is 4.09 out of 5. Of the freshman class represented in this sample, 14% graduated from high schools with special emphasis on science education. Of all freshman body, 72% of the students have a time lapse between the entrance year and the attending to the faculty courses. This time period is spent either in English Preparatory school or by leave-of-absence, at least for one semester.
Although we do not report here, the sample averages show that if there is a time gap between the university entrance exam and the registration to the courses, the average FGPA of these students is 1.956, whereas the students directly attending to the courses have an average FGPA of 1.975.

Of freshman students, 42.8% receive tuition waivers, either government or university provided. When we separate the sampled freshman GPAs by the type of tuition waiver, as Table III shows, we observe that students receiving government type waiver (GOV_Waiver) perform better in terms of FGPA compared to students paying their own tuition (NO_Waiver) and to students receiving tuition waivers from the university (UNI_Waiver). It should be noted that, under normal conditions, a student whose GPA is lower than 2.00 for two consecutive semesters loses tuition scholarship. But considering most of the students attend to department courses at fall semester and the FGPA is defined as the latest record of each fall semester, students have a chance to raise their GPA during summer school.

When the type of the high school, as private or public, is investigated, the sample reveals that 33% of the students graduated from a private high school, the FGPA of these students are found to be 1.702, whereas, the students graduated from public schools have a FGPA of 2.089.

This hypothesized relationship is summarized by the following equation:

\[
FGPA = \alpha + \beta_1 \text{Gender} + \beta_2 \text{WaiverType} + \beta_3 \text{TimeGap} + \beta_4 \text{HSType} + \beta_5 \text{HSScience} + \beta_6 \text{Region}
\]  

(1)

Table V summarizes the results. The student’s loan type exerts a statistically significant effect on freshman GPAs only if the student receives government type waiver. All else equal, a student who received government type tuition waiver performs better by 0.689 points in FGPA compared to a student who pays tuition out-of-pocket. On the other hand, there is no statistically significant difference between students who receive tuition waivers from the university and who pays tuition themselves. Compared to male students, female students perform better in terms of GPA during freshman year. All else equal, a male student’s GPA is 0.18 points less than a female student’s GPA at the end of first year in the engineering school of Yeditepe University. Whether or not the student attends English preparation school upon entry has no statistically significant effect on the student’s first year performance.

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In order to analyze whether or not the tuition type, high school GPA, university exam ranking and gender continue to exert any statistical effect on student achievement during engineering education, we proceed in two steps. First we regress cumulative GPA (CGPA) on the cumulative number of credits attended by the student. From this regression analysis, we capture the residuals, i.e., the variation in CGPA that is not explained by cumulative credits. In the second step, we regress residuals onto the factors which we are mainly interested in. In doing so, we eliminate the variation in CGPA that is correlated with credits and try to explain the remaining variation in CGPA by high school type, loan status and gender, and other factors. We report the results from first step of our analysis and the figure depicting the relationship between residual variation in CGPA and cumulative credits in Table VI and Figure 3.

II. All Students

The analysis above presents factors that are relevant for the students’ achievement during their first year. What can we say about student achievement, as measured by GPA, for the duration of their study? In this case, one has to consider that the student's GPA will be closely related to the number of credits taken during the course of the study. Indeed, when we extend our sample from freshman year to all students attending engineering faculty, we observe that the number of credits is closely related to the student GPA. The graph below depicts this relationship.

When we compare the sample statistics for all engineering students with the freshman year, we observe that the percentage of male students is slightly higher. Of all freshman students, 72.8% are male, whereas of all engineering students, 75.5% are male. Table VII reveals that, compared to freshman year CGPAs, overall engineering school average CGPAs are slightly higher on the average, 2.01. The share of students receiving some kind of tuition waiver is close to freshman averages; between years 2002 and 2005, 43.2% of students of the engineering school received some kind of tuition waiver. The average CGPA of these students is 2.559, on the other hand, students paying their own tuition have an average GPA of 1.568. The sample averages show that students receiving...
government type waiver have an average GPA of 2.756, whereas the university waived students have CGPA of 1.78. This could be explained by the fact that for students to maintain their tuition scholarship status, their semester GPAs should be above 2.00 once in two consecutive semesters.

When the type of the high school, private vs. public, is investigated, we see that 33.8% of the students graduated from a private high school, the CGPA of these students is on the average 1.749, whereas, the students graduated from public schools have a CGPA of 2.148. We have to note that the average CGPA of all male students in the engineering faculty is 1.994, whereas the female students have an average CGPA of 2.075. A brief comparison of freshman year sample with the overall student body characteristics, presented in Table VIII, reveals that the factors that are of importance for our study are quite similar in these two samples.

We report the results pertaining to the relationship between the unexplained variation in CGPA and the explanatory factors that are of interest for this study in Table IX. As far as the gender of the student is concerned, the results suggest that in Yeditepe University, female engineering students perform better compared to male students, at all class levels. Students who receive government type tuition waiver, on the average, attain 0.541 points higher CGPA, compared to students who pay tuition with their own finances. We have to note that the relationship between student CGPA and the university based tuition waiver is now positive, compared to the negative, but statistically insignificant, result for the freshman year. The results suggest that university based tuition waivers may be effective in the long run, or selection strategy changes as the students progress in their studies. As was the case for the freshman years, the type of the high school, public or private, does not matter in overall CGPA performance of the engineering students. We also observe that for the overall engineering school student body, all else equal, a student who attended privately owned science curriculum based high school achieves a lower CGPA compared to a student who had attended a public, normal curriculum high school. Whether this result indicates the relative inefficiency of privately owned science high schools or not deserves further research. The rank and high school GPA of the student continue to be important predictors of the student success. All else equal, students who achieved higher ranking in the university entrance exam, and students who graduated with higher GPAs from high school continue to have higher CGPAs throughout their studies in the engineering faculty.

We discussed in the previous section that adjustment to a new city may arise as an important factor in student achievement during the first year. With the exception of one region, Black Sea, on average, a freshman student who attended high school in another region attained lower GPA compared to a student who attended a regional high school. We also noted that there may be variations in educational quality across the regions, and it is possible that the regional differences in CGPA reported in freshman analysis may reflect these region based variations in educational outcomes. Indeed, both explanations may be relevant. For instance, for the overall student body, the statistical difference across regions in explaining student CGPAs disappear for the overall engineering school student body, all else equal. There is an educational quality difference across regions in explaining student CGPAs, which is evident from the results presented in Table IX.

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such as bolstering student academic background with extra classes, may be needed.

**CONCLUSION**

In this study, factors which are hypothesized to be important in explaining student achievement are analyzed. For this purpose, the study focuses on two outcome variables, freshman year GPA and all class level GPA, for the engineering students of a private university in Turkey. The primary interest of this study is whether university entrance exam rank appears as a statistically significant predictor of college success. The student waiver type, gender of the student and high school GPA and type comprise other factors of interest.

Our results suggest that female students perform consistently better than male students, both in freshman class and throughout their engineering education. Students who receive waiver from the government, all else equal, attain higher GPAs. Since the data at hand do not include detailed information on student socioeconomic background, our study can not distinguish the direction of causality on this factor. Whether these students who receive waiver from the government are more motivated, and have higher ability, or whether the waiver conditions propel students to achieve better, this question arises as an important point for future research. As for students who receive waiver from the university, our study reveals that, at least for engineering students, a re-design of the waiver allocation policy may be needed, for our study fails to establish a positive relationship from university waiver to student GPA. For freshman students, adjustment to a new city appears as an important impediment for their success. In time, the regional differences disappear, but not completely. The results of this study point to the need of designing and improving orientation programs for new students, so to ease their transition from home to university environment.

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**REFERENCES**


