

Variables that may predict the behavior of a student in his/her university life at Polytechnic University of Puerto Rico

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Abstract

The objective of this study is to establish the relationship, if any, between the Graduation Grade Point Average (GPA) of students that began as first year students at Polytechnic University of Puerto Rico and remained until graduated, with the High School Grade Point Average and the College Board achievement indexes in Mathematics, English and Spanish. The study measures how close this relationship can predict success of applicants.

Sinopsis

Variables que pudieran predecir el comportamiento de un estudiante en la Universidad Politécnica de Puerto Rico

Este estudio tiene como objetivo establecer la existencia de una relación, si alguna, entre el promedio de graduación de los estudiantes que comenzaron desde su primer año en la Universidad Politécnica y obtuvieron su grado, con el promedio de escuela superior y los índices de aprovechamiento del "College Board" en matemáticas, español e inglés. El estudio intenta determinar cuán bien puede esta relación predecir el éxito de los estudiantes que solicitan.

A. Introduction

One of the most serious situations found in student behavior is a high withdrawal rate. Many universities are facing this problem by employing

diverse strategies but to no avail. The Polytechnic University of Puerto Rico (PUPR) has pointed out many times to all the licensing and accreditation agencies evaluating it that student retention is probably the most serious problem the University faces. PUPR has indicated to the Council of Higher Education, to the Middle States Association (MSA)¹, and to the Accreditation Board for Engineering and Technology (ABET)² that about 32% of the students enrolled as first year students drop out by the end of their first year. The withdrawals continue until only about 12% of a given freshmen class finish all the requirements to obtain the degree in the prescribed period of four or five years, whichever is applicable. The questions most frequently asked internally are: Is it due to the open admission policy in which a high school index of 2.00 and a College Board Achievement Tests total of 1300 points minimum are required? Is it the financial situation of the students and their parents that forces them out? Is it true that over 80% of those who come from K-12 programs are inadequately prepared and are not capable of navigating through and surviving a university degree program? What are the variables which truly predict that a high school graduate will succeed in obtaining a bachelor's degree and become a competent professional in the discipline chosen?

The aim of the PUPR is to attract the best potential candidates who will perform outstandingly as college students in the engineering, architecture, land surveying and business administration disciplines. For this reason the PUPR conducted a study employing the documentation available in the Registrar's office for all the students coming directly from high school that succeeded in obtaining a degree. The idea behind the study was to determine indicators who may point to a correlation between high school academic excellence and

¹ Selfstudy Presented to the Commission On Higher Education of Middle States Association of Colleges and Schools submitted December, 1994.

² Self-Study Questionnaire for Review of Engineering Programs 1995-96, Edition Volume 1 Submitted to ABET June 10, 1995.

college performance.

Presently, PUPR is basing admission on the following indicators: High School GPA and College Board Achievement Tests (Spanish, English and Mathematics). These indicators were tested statistically in an effort to identify a possible correlation between the achievement indicators and high school GPA with the college GPA. Based on the results of this study, the PUPR administration is on the verge of adopting a new revised admission policy.

1. Assumptions

In order to carry out the statistical analysis of students' data, to reach valid conclusions, the following assumptions were made:

- Aside from GPA, it was assumed that every human being has the inalienable right to aspire to a higher education. A corollary of this statement is that all students admitted to the programs were highly intelligent and capable of learning and being trained in the discipline the student chose.
- The grading system employed is adequate and able to measure and categorize how successful the student is.
- Although a somewhat risky assumption, it was assumed that external factors of the student's life, but not directly related to the teaching-learning process (family income level, number of family members, etc.) do not affect the capacity of learning. Finally, it was assumed that the heterogeneity in faculty personality, academic preparation, gender and work experience, does not adversely influence the grades and the general GPA of a student. Following the same line of thought, this assumption also relates to the negligible effect, if any, of the physical environment at the University Campus such as air conditioned rooms, class room size, number of students per class on the teaching-learning process and the grading of student work.

2. Method

PUPR had awarded 1,808 bachelor degrees up to July 1995: 416 were awarded to students admitted from high school; the other 1392 were earned by transfer students, mainly from the University of Puerto Rico, Mayaguez Campus. The five indexes mentioned earlier were analyzed for the students admitted from high school by using the statistical software called Statgraphics Plus, version 6 (Table 1)

Table 1. Statistical variables for the five indexes

Variable	GPA		College Board index		
	College	High School	Mathematics	Spanish	English
Sample size	359	359	359	359	359
Average	2.81	3.01	567.24	503	448.85
Median	2.77	3.03	564	496	431
Mode	2.51	3	644	475	370
Standard deviation	.3396	.51	85.4	75	91.75
Minimum	2.09	1.1	346	314	290
Maximum	3.78	4.00	780	760	730
Range	1.69	2.9	434	446	540

This software allowed for the making of a correlation analysis for the five variables mentioned. Correlation analysis often provides a preliminary view of the relationships among variables. Correlation coefficients provide a normalized and scale-free measure of the linear association between two or more variables. The coefficient values fall between -1 and +1. A positive correlation indicates that the linear relationship of the variables has a positive slope whereas the negative correlation indicates a negative slope. The correlation analysis procedure calculates Pearson product-moment correlation and assumes that the data follow a normal distribution. Figure 1 shows that the data used for College GPA follow a normal distribution, satisfying this Statgraphics requirement.

After the data were entered into the computer, the system computed the correlation matrix and displayed the results (Table 2). Each row and column of the matrix corresponds to a variable. Three numbers appear in each cell of the matrix: a) the correlation coefficient for the variables represented by the cell, b) the sample size (in parenthesis), and c) the significance level of the correlation.

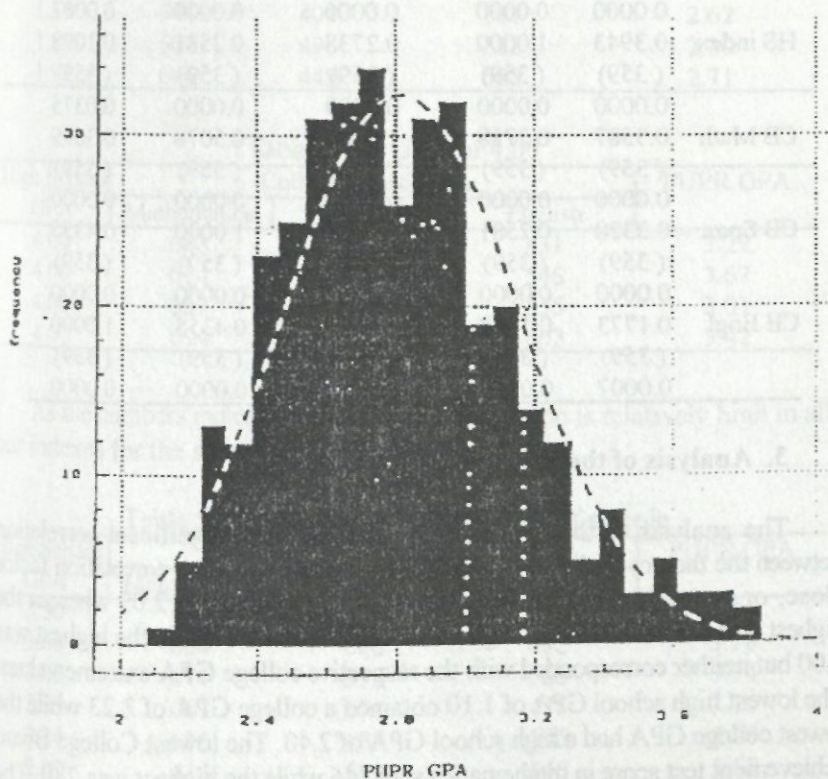


Figure 1. Frequency histogram

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Table 2. Sample correlations

	GPA	High School index	College Board index		
			Mathematics	Spanish	English
GPA	1.0000 (359)	0.3943 (359)	0.3587 (359)	0.3328 (359)	0.1773 (359)
HS index	0.0000	1.0000	0.0000	0.0000	0.0007
CB Math	0.3943 (359)	0.3943 (359)	0.2738 (359)	0.2581 (359)	0.1098 (359)
CB Span	0.0000	0.0000	0.0000	0.0000	0.0375
CB Engl	0.3587 (359)	0.2738 (359)	1.0000 (359)	0.5078 (359)	0.3699 (359)
	0.0000	0.0000	0.0000	0.0000	0.0000
	0.3328 (359)	0.2581 (359)	0.5078 (359)	1.0000 (359)	0.4355 (359)
	0.0000	0.0000	0.0000	0.0000	0.0000
	0.1773 (359)	0.1098 (359)	0.3699 (359)	0.4355 (359)	1.0000 (359)
	0.0007	0.0375	0.0000	0.0000	0.0000

3. Analysis of the data

The analysis of the data shows that there is no significant correlation between the factors studied. None of the indicators exhibit a correlation factor close, or equal, to +1 or -1. The lowest college GPA was 2.09 whereas the highest was 3.78. The lowest High School GPA was 1.1 while the highest was 4.00 but neither corresponded with the respective college GPA extreme values. The lowest high school GPA of 1.10 obtained a college GPA of 2.23 while the lowest college GPA had a high school GPA of 2.40. The lowest College Board achievement test score in mathematics was 346 while the highest was 780. The lowest Spanish score was 314 and the highest was 760. The lowest English score was 271 while the highest was 730. The lowest sum of the three College Board indexes was 964 while the highest was 2026.

Four students in the sample having a high school GPA between 1.10 and 1.93 (Table 3) did graduate.

Table 3. HS GPA lower than 2.00

High School GPA	College Board index			PUPR GPA
	Mathematics	Spanish	English	
1.10	455	409	382	2.23
1.53	541	404	341	2.62
1.89	604	496	532	2.30
1.93	646	449	588	2.71

Table 4. HS GPA of 4.00

High School GPA	College Board index			PUPR GPA
	Mathematics	Spanish	English	
4.00	688	550	431	3.22
4.00	614	522	546	3.67
4.00	667	578	555	3.01
4.00	694	640	602	3.42

As the numbers indicate in Table 4, the dispersion is relatively high in all four indexes for the same high school GPA of 4.00.

Table 5. Highest seven PUPR GPA's of sample

High School GPA	College Board index			PUPR GPA
	Mathematics	Spanish	English	
3.30	504	508	416	3.78
3.66	654	606	482	3.78
3.09	674	572	588	3.74
2.99	667	671	475	3.76
3.84	616	485	395	3.68
2.99	614	522	546	3.67
3.21	664	640	595	3.67

Similarly, a large spread in H.S. GPA may produce a very narrow spread in the PUPR GPA as Table 5 shows.

4. Inferences

The analysis of the data allowed PUPR to make the following inferences:

- Neither the High School index nor the College Board Entrance Examination board tests individually correlate with the College GPA; therefore they are not reliable predictors of success for a student in obtaining a bachelor's degree at the PUPR.
- Provided the physical health of the students allows them to attend classes regularly and have a steady financial support to cover all their expenses, some other factors beyond High School GPA and CBEE tests should be taken into consideration in order to explain the lack of correlation found and to increase the probability of succeeding at PUPR.

B. Theory

Psychologists and education researchers have been increasingly interested in understanding the teaching-learning process and how it is affected or influenced by the functioning of the brain. Some of the most recent theories proposed are briefly summarized here.

1. Multiple types of intelligence

Thomas Armstrong (1994) guides his readers through Howard Gardner's powerful theory of multiple intelligences providing concrete examples of how the theory can be applied to curriculum development, teaching strategies, classroom management, assessment, special education and other areas. Key points in the multiple intelligences theory are: a) each person possesses all seven types of intelligences, b) most people can develop each intelligence to an adequate level of competency, c) intelligences usually work together in complex ways, and d) there are many ways to be intelligent within each category.

The seven intelligences are briefly described:

1. Linguistic intelligence: the capacity to use words effectively whether orally (such as a story teller, orator or politician) or in writing (as a poet, playwright, editor or journalist).
2. Logical-mathematical intelligence: The capacity to use numbers effectively (as a mathematician, accountant or statistician) and to reason well (as a scientist, computer programmer, logician or engineer).
3. Spatial intelligence: The ability to perceive the visual-spatial world accurately (as a hunter, scout or guide) and to perform transformations upon those perceptions (as an interior decorator, architect, artist or inventor).
4. Bodily-kinesthetic intelligence: Expertise in using one's whole body to express ideas and feelings (as an actor, an athlete or dancer) and facility in using one's hands to produce or transform things (as craftsman, sculptor, mechanic or surgeon).
5. Musical intelligence: The capacity to perceive (as an amateur musician), discriminate (as a music critic), transform (as a composer) and express (as a performer) musical forms.
6. Interpersonal intelligence: The ability to perceive and make distinctions in the moods, intentions, motivations and feelings of other people.
7. Intra personal intelligence: Self knowledge and the ability to act adaptively on the basis of that knowledge.

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Are we at the PUPR providing the means to allow students to develop each intelligence to an adequate level of competency in order to succeed in their studies?

2. Exemplary teaching

College instructors differ, among many other things, in teaching ability, in their initial level of success and in their eventual mastery of the skills needed to plan and deliver a course of the highest quality. Joseph Lowman (1995) proposes a two-dimensional model of effective college teaching. The effectiveness depends upon creating both intellectual excitement and interpersonal rapport with students. The skill to generate excitement and the skill to establish rapport are relatively independent. Excellence at either one can ensure effective teaching with some students and in certain kinds of classes; a teacher who is accomplished at both is most likely to be outstanding in meeting a variety of goals for all students and in any setting (Table 6).

3. Hardy and resilient students

Probably, as pointed out by Sylwester (1995), hardy adults, because of their boldness, self confidence, inurement to fatigue or hardship, have learned how to effectively use their brain's problem solving capabilities. In doing so, they view change as a constant in life and welcome it as a challenge to grow; they have a strong commitment to the significant relationships in their life, and they have an internal locus of control.

At the same time, he indicates that some children can adapt successfully to the problems they face during the growing-up years, becoming resilient. Normally they are healthy, active sociable children with a pleasant personality; they are curious and interact physically with their environment; have family and non-family mentors who provide them with unconditional love; are assigned responsibilities in a home environment reasonably well structured; and develop a positive self concept and an internal locus of control.

Are these characteristics, resilience and hardiness, strong enough to guarantee academic success to any student in possession of them?

4. Personality preferences

Otto Kroeger and Janet M. Thuesen (1988) affirm that in accordance with the theory of C.C. Jung, human behavior is not random but is in fact predictable and, therefore, classifiable. According to this theory human beings are born with a predisposition for certain personality preferences. In type watching, there are four pairs of preference alternatives. The person is either:

- Extraverted or introverted
- Sensing or intuitive
- Thinking or feeling
- Judging or perceiving

These leanings, says Jung, reflect both genetic predispositions and whatever else is part of the earliest moments. As life develops, the environment influences the direction the preferences will take. It is said that the first day of school can be an exciting adventure to an extraverted child; but to an introvert it can be intimidating at best, a nightmare at worst.

A great deal has been written and published about education and personality types. Grades K through six, it has been observed, are heavily sensing-oriented, always doing things. Starting about seventh grade, theory increases, intensifies during college, and peaks in graduate school, progressively moving from sensing to iNtuitive. Accordingly, grade school teachers are about two thirds sensing, high school teachers about evenly split between sensing and iNtuitive, and college faculties about 70 percent iNtuitive (some graduate school faculties are as high as 77 percent iNtuitive). The sensing and iNtuitive teaching dichotomy results in sensors becoming the doers of the various disciplines - the doctors, grade school teachers, engineers, and lawyers - and iNtuitive becoming the teachers of medicine, education, engineering and law.

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Are these different personality types the determining factors in success of engineering, architecture, business administration and other PUPR students?

Table 6. Two-dimensional model of effective college teaching*
Dimension II Interpersonal rapport

	Low: Cold, distant, highly controlling, unpredictable	Moderate: Relatively warm, approachable and democratic, predictable	High: Warm, open, predictable and highly student centered
High: Extremely clear and exciting	Cell 6: Intellectual Authorities. Outstanding for some students and classes but not for others	Cell 8: Exemplary Lecturers Especially skilled in large introductory classes	Cell 9: Complete exemplars excellent for any student and situation
Moderate: Reasonably clear and interesting	Cell 3: Adequate: Minimally adequate for many students in lecture classes	Cell 5: Competent Effective for most students and classes	Cell 7: Exemplary facilitator especially skilled in smaller, more advanced classes
Low: Vague and dull	Cell 1: Inadequate Unable to present material or motivate students well	Cell 2: Marginal Unable to present material well but liked by some students	Cell 4: Socratic Outstanding for some students and situations but not for most

5. Visualization

Stephen R. Covey (1989) talks about visualization as an effective mechanism to influence the thought process in order to help oneself to achieve definite autosuggested goals. He recommends: "Expand your mind. Visualize in rich detail. Involve as many emotions and feelings as possible. Involve as many of the senses as you can." "I have done similar of my university classes," he said. "Assume you only have this one semester to live," he tells his students, "and that during this semester you are to stay in school as a good student. Visualize how you would spend your semester." "A good affirmation has five basic ingredients: it is personal, it's positive, it's in the present tense, it's visual, and it's emotional," he continues.

Dr. Covey mentions that Dr. Charles Garfield has done extensive research on peak performers, except in athletics and business. He has been fascinated with peak performance in his work with the NASA program, watching the astronauts rehearse everything on earth, again and again, in a simulated environment before they went to space.

One of the main things Dr. Garfield's research showed was that almost all of the worldclass athletes and other peak performers are visualizers. "They see it. They feel it; they experience it before they actually do it."

To what extent are the good PUPR students employing visualization to help themselves become high achievers? Is this a good explanation for some PUPR students who had low grades in high school and became excellent students afterwards?

C. Competitive universities' admission indexes

In the impossibility of statistically showing the wisdom of employing the admission indexes actually in use, an effort was made to review the literature and try to identify factors that may influence the performance of a student. At the same time, an analysis of the indexes used by most of the competitive colleges in the USA was made. In the United States the most prestigious

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universities, as reported by Clifford J. Caine (1988), require the evaluation of these four factors: academic record, test scores, leadership and activities.

1. The academic factor

The single most important factor for admission to a competitive college in the USA is the student's high school academic record. However, contrary to the way this factor is used at the PUPR, it does not mean just the grades and scores. Increasingly, competitive colleges look for grades as well as the kinds of college preparatory courses such as honors English, trigonometry, physics, and chemistry the student may have passed. Also, they take into consideration whether the student comes from public or private school by assigning a higher range, expressed as a percentage to each one of three elements from five which constitute the academic factor. The way they assess the academics of public high school students is by assigning four points. Whenever the student finishes in the top two fifths or 40% of the class. Two more points are granted when the student is in the top one-fifth or 20% of the class. Another point is given when the student is in the top 10% of his class. Thus 7 of possible 10 academic points are achievable through class rank factors. Additionally, the student may earn two points if his/her score is very high on the Preliminary Scholastic Aptitude Test (PSAT) and the National Merit Scholarship Qualifying Test (NMQST), and received recognition as finalist, semifinalist or letter of commendation status. Whenever the student receives a letter of commendation from the National Merit Scholarship Corporation, he or she earns one additional point. In the same way, this last point may be earned if recognition comes from the Cum Laude Society or the National Honor Society for a total maximum of 10 points (Table 7).

2. The testing factor

The Scholastic Aptitude Test (SAT) of the College Entrance Examination Board and the American College Test (ACT) of the American College Testing Program are two fundamental standardized tests used in the United States (Table 8). One or the other is required by most of the colleges. No matter how

many questions may be raised regarding the importance of these standardized tests, certainly they are very significant. Having a variety of secondary schools of widely varying difficulty, so that what may be an "A" at one place may be equivalent to a "C" at another, the standardized testing can serve as an equalizing factor that brings an element of fairness into the admissions procedure.

Table 7. Academic factor

Academics	Points	You
Top 40% of class (public) or Top 60% of class (private)	4	
Top 20% of class (public) or Top 30% of class (private)	2	
Top 10% of class (public) or Top 20% of class (private)	1	
National Merit Semifinalist/finalist	2	
National Merit Commended or Cum Laude Society of National Honor Society	1	
Total (Max)	10	

Table 8. Test scores

Testing	Points	ACT Composite	Points
SAT Verbal			
650-800	5	30-36	10
600-649	4	29	9
550-599	3	28	8
500-549	2	27	7
400-499	1	25-26	6
SAT MATH	---	23-24	5
650-800	5	22	4
600-649	4	21	3
550-599	3	20	2
500-549	2	18-19	1
400-499	1		
Total	10		10

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3. The leadership factor

Special leadership qualities are often important factors in determining admission to competitive colleges. Students who have shown real leadership in several areas, thus indicating outstanding and continued leadership potential, are looked at with special interest by many competitive colleges (Table 9).

Table 9. Leadership

Leadership	Points	You
Pres. of class, Pres. of student council or both	2	
Editor-in-Chief of school yearbook or newspaper	2	
Class officer or student council member	1	
An editor of a school publication	1	
Student director of a school organization	1	
Officer in religious or civic organization	1	
Major school leadership award	1	
Major religious or civic leadership award	1	
Total (Max)	10	

4. The activities factor

Almost all colleges are looking for a well-rounded, versatile student body with a high proportion of students who have made significant contributions to their school and community. Student involvement in worthwhile extracurricular activities provides an understanding of his or her life and personality. Successful students are people actively involved in their education both within and outside class (Table 10).

Table 11 presents the prediction indexes used by some prestigious, well known universities in the United States with very high standards, one for each total from 29 to 14 points.

Table 10. Activities

Activities	Points	You
A coordinator of community service activity (bloodmobile, food drive, United Way, etc.)	2	
Community service	1	
Received all-conference sports recognition or equivalent	2	
Lettered in one or more varsity activities	1	
Special proficiency in speech activities or in fine arts (arts, theater, dance, music)	2	
Proficiency in fine arts	1	
Membership in one or more school or community clubs or regular part-time job	1	
Total (Max)	10	

Table 11. Prediction indexes of some prestigious universities in the United States

College or University	Academic	Testing	Leadership	Activities	Total
Harvard	10	10	5	4	29
Princeton	10	9	5	4	28
Johns Hopkins	10	9	4	4	27
Duke	9	9	4	4	26
Cornell	9	8	4	4	25
U Ca at Berkeley	9	6	4	5	24
U of MI at Ann Arbor	9	7	3	4	23
Rensselaer	9	8	2	3	22
Carnegie-Mellon	8	8	2	3	21
Georgia Tech	9	6	3	2	20
UCLA	7	5	3	4	19
Stevens	7	6	3	2	18
Penn State	7	5	2	3	17
George Washington	5	5	3	3	16
Drexel	5	4	3	3	15
Purdue	6	4	2	2	14

D. Implications

The application or use of the academic record as it is used at present by PUPR does not constitute a good predictor of success. A better way would be to adopt a system similar to the academic factor employed by competitive universities in the United States.

With regard to the College Board Achievement test, the statistical analysis demonstrates it does not constitute a good predictor of success. The aptitude tests are the fundamental standardized tests in the United States. The use of the achievement tests should be discarded for admission purposes and replaced by the aptitude test. In the event of using the aptitude tests they should be used as in the Competitive Universities in the United States.

The leadership and activity factors, as defined and used by the Competitive Universities, may constitute an initiative to take in consideration some of the elements pointed out by the psychologists in different theories described here. Therefore, PUPR should consider seriously the introduction of these factors in the equation used for admission of students from high school.

It is highly recommended that the PUPR adopt a college entrance predictor with a total of 14 points using the combination of the academic, testing, leadership and activity factors that best fit its needs.

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Abstract

Energy power, type of the energy, demand of the world, social facing
the global problem

This article attempts explaining the short- and long-range perspectives of energy requirements as a function of several factors such as national policies, transport and population. These are, well as any local, dependent variables the main part of the human called energy demand. Therefore, it is important to observe how energy demand is affected by these variables. By extrapolating its values into the future we could see a delicate situation. There will be sharp changes in the lifestyles because the environment in which we interact will be degraded. The constraint of fossil energy resources will force us to use