Mapping the relation between University access test and student's university performance

Test d'accesso e performance universitaria

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Abstract The access test is the most used tool to evaluate the initial preparation of an italian student before enrolling at the university. Although the necessity to select the most deserving students seem unquestionably reasonable, we have to wonder if it appears to be a good predictor of university performance. In order to answer this question, the university careers of the students enrolled at two Degree Courses at the University of Palermo (academic year 2013/2014) were analysed. The very aim of this paper is to propose a graphical tool, the Student Efficiency Nomogram, that shows the access test scores together with the first-year performance of the student.

Abstract *Lo strumento più utilizzato in Italia per verificare la preparazione iniziale di uno studente universitario è il test d'accesso. Per quanto la necessità di selezionare gli studenti più meritevoli appaia indiscutibilmente ragionevole, bisogna chiedersi se il test d'accesso risulti essere un buon predittore della futura performance universitaria. Per rispondere a tale quesito sono state analizzate le carriere universitarie degli studenti di due corsi di laurea immatricolati presso l'Università degli Studi di Palermo nell'A.A. 2013/2014. In questo lavoro proponiamo uno strumento grafico, il Nomogramma d'efficienza studentesca, per mettere in relazione i punteggi conseguiti al test d'accesso con la performance dello studente alla fine del primo anno di studi universitari.*

Key words: Selective access test, first-year university career, Student Efficiency Nomogram

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1 Introduction

The Ministerial Decree n. 270 enters in force on 20^{th} October 2004, establishing that an adequate initial preparation is required among the minimum prerequisites to access a degree course. The most used tool to evaluate the initial preparation of a student is the access test, which is intended to select the most deserving students who will potentially continue their studies with success.[2]

The goal of this study is to understand if there exist a relationship between the access test and the student's performance. For this purpose, the analysis was carried out on the student population of two degree courses, say A and B, enrolled at the University of Palermo in the academic year 2013/2014.

2 Data and variables

The analysed dataset was provided by Sistema Informatico d'Ateneo. The dataset consisted of 504 records in 10 variables, where each record identify a statistical unit, i.e. a student enrolled on one of the two degree courses during the academic year 2013/2014. The dataset was made up of information about the student's university career and information about the score at the access test, where the latter were provided by one of the Companies in charge for the Access tests at the University of Palermo. The variables taken into account were the number of ECTSs earned the student at the end of the first academic year, the average mark at the end of the first year, and the scores for each area of knowledge. The areas of knowledge for Degree course A were Law and Economics; Italian; Logic and Philosophy; History. For degree course B they were Biology; Chemistry; Physics; Mathematics.

The analysis was focused on the first-year university career, as it has been shown that the first year is a good predictor of student performance. According to our goal, we decided to calculate the number of years expected to obtain the degree as the ratio between the number of ECTSs to get the degree (180-300 in Italy) and the number of ECTSs actually earned by the *i-th* student at the end of the first year.[1]. Actually, this is a rough prevision of the time to get the degree, but this is not the aim of this paper.

3 Student Efficiency Nomogram

According to our goal, we decided to propose a graphical method which can simultaneously evaluate different student performance indicators. The graphical method shows simultaneously: the student's average mark; the number of ECTSs earned at the end of the first year; the number of years expected to obtain degree; and the access test score.

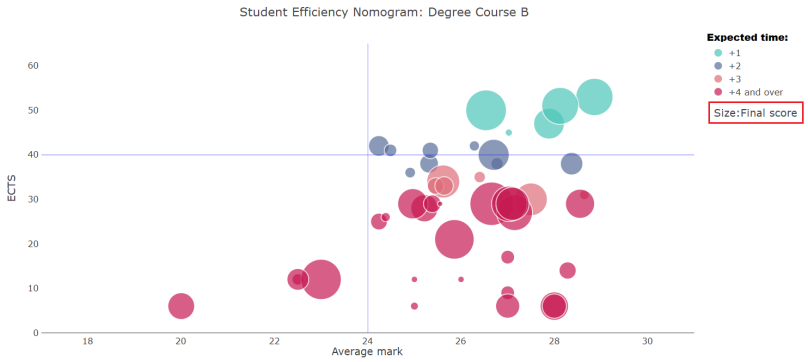

Fig. 1 Student efficiency Nomogram: Degree Course B, final score

As shown in Figure 1, the Student Efficiency Nomogram can be represented in a Cartesian coordinate system. On the horizontal axis it shows the student's average mark and on the vertical axis it shows the number of credits acquired by the student at the end of the first year. The origin of the Cartesian axes is fixed at the point of coordinates (24, 40), this choice was made in accordance with the MIUR directives. Indeed, according to the Ministry point of view, a student earning more than forty ECTSs at the end of the year is considered an efficient student.[3]

Looking at average mark, it has been decided to divide the range of values into two parts. Where, under 24, we identify a student below average and vice versa a student above average. In addition, the pair of points ($ECTS_i$, $Average\ mark_i$) identifies the number of ECTSs and the average mark of the *i-th* student at the end of the first academic year.

According to this graphical method, we have three possible scenarios: *i)* the student is highly efficient ($ECTS > 40$, $Average\ mark > 24$); *ii)* the student is inefficient ($ECTS < 40$, $Average\ mark < 24$); *iii)* the student is in an in between situation: efficient, but he/she doesn't show high marks or he/she is not efficient but with high mark ($ECTS > 40$, $Average\ mark < 24$ or $ECTS < 40$, $Average\ mark > 24$).

In addition, we were also interested in evaluating the information regarding the number of years expected to obtain degree and the access test score. In order to take into account this information in the graph, we assign to each observation a colour which identifies the time expected for the degree and we scale the point size proportionally to the scores gained at the access test. So, if on the one hand this tool allows to understand if the student is efficient or not, on the other hand it allows to verify if the access test was a good tool to evaluate students at the entrance. Indeed, if it was a good tool, you would expect to identify in the upper right quadrant, students with a high access test score, while in the lower left quadrant, students with a low score.

4 Results

From Figures 1 and 2 e) we can see that only 20% of the statistical units falls into the efficiency region. It is also necessary to point out that the size of the point, which expresses the total score obtained in the access test, seems to be randomly distributed among the regions of the graph. Moreover, with the exception of only 3 statistical units for Degree Course A, none of the observed students, according to the indicator used in this paper, will take is degree in time (3-5 years).

Fig. 2 Student efficiency Nomogram, Degree Courses A and B

We were interested in evaluating each areas of knowledge and in particular, we wanted to understand if at least one of the areas of knowledge of the access test was a good predictor of the student's career.

Figure 2 shows the Student Efficiency Nomograms of both the degree courses related to each areas of knowledge. We can notice that all areas of knowledge do not appear as good predictors of the university career performance. Anyway, Biology and History seem to have a greater discriminant effect, but not enough to call them predictors of student's performance.

To validate our graphical method a zero-one inflated (Course A) and a zero inflated (Course B) model were applied [4, 5], and in particular we have analyzed the relationship between the fraction of ECTSs and the set of explanatory variables for both the Degree Courses.

Table 1 Model coefficients of Degree Course A

μ **(fraction)**	**Estimate**	**S.e**.	***p-value***
Intercept	−2.70	0.39	0.000
Law and Economics score	0.45	0.29	0.12
High school mark	0.02	0.004	0.000
Classical high school	0.24	0.21	0.26
Teacher-training high school	−0.12	0.27	0.64
ITC high school	−0.36	0.29	0.21
Scientific high school	0.18	0.22	0.41
Male	−0.19	0.09	0.03
α **(zero-inflated)**	**Estimate**	**S.e.**	***p-value***
Intercept	5.40	1.66	0.001
History score	−1.99	1.25	0.11
Law and Economics score	−2.34	1.34	0.08
High school mark	−0.04	0.02	0.01
Classical high school	−2.53	0.62	0.000
Teacher-training high school	−0.68	0.67	0.30
ITC high school	−0.88	0.74	0.23
Scientific high school	−2.09	0.63	0.001
τ **(one-inflated)**	**Estimate**	**S.e.**	***p-value***
Intercept	−18.46	8.79	0.03
High school mark	0.15	0.09	0.09
ϕ **(precision)**	**Estimate**	**S.e.**	***p-value***
Intercept	−0.43	0.04	0.000

Looking at Table 1 (Degree Course A), we can notice that the History score, and the Law and Economics score reduce the probability of obtaining zero ECTSs at the end of the first year, but they haven't a significant effect on average (Table 1 - top section). Table 2 (Degree Course B) shows a reduction in probability of obtaining zero ECTSs due to the Physics score Table 2 - mid section), but we can notice only a significant positive effect on average (Table 2 - top section) due to the Biology score. The same analysis was carried out analyzing the relationship between the *Average mark* and the set of explanatory variables, whithout obtaining results significantly different from those in Tables 1 and 2.

Table 2 Model coefficients of Degree Course B

μ **(fraction)**	**Estimate**	**S.e.**	***p-value***
Intercept	−8.72	1.29	0.000
Physics score	1.06	0.66	0.11
Chemistry score	−2	0.89	0.03
Biology score	3.39	1.55	0.03
High school mark	0.05	0.007	0.000
Classical high school	1.13	0.32	0.001
Scientific high school	1.02	0.19	0.000
Male	0.76	0.17	0.000
Public school	1.13	0.62	0.07
α **(zero-inflated)**	**Estimate**	**S.e.**	***p-value***
Intercept	−1.48	5.53	0.78
Classical high school	−4.15	2.03	0.04
Scientific high school	−3.55	1.68	0.04
Physics score	−6.34	3.81	0.10
High school mark	0.06	0.06	0.32
ϕ **(precision)**	**Estimate**	**S.e.**	***p-value***
Intercept	20.37	0.02	0.000
Classical high school	−19.14	0.31	0.000
Scientific high school	−18.28	0.26	0.000

According to these results, we can conclude that our graphical tool is an easy way to analyze the student performance in relationship with access test.

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