The Role of Organisational Variables in the Academic Performance of Higher Education Students

El Rol de las Variables Organizacionales en el Rendimiento Académico de Estudiantes de Educación Superior

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Abstract

This study focuses on the relevance of organisational variables as possible factors that influence the academic performance of students at a Chilean higher education institution. Data were collected from students who took different subjects between the years 2013 and 2015. A quantitative design was applied using multilevel logistic regression models to predict students' failing rates in the subjects of mathematics, physics and chemistry. Results show that programming class schedules and the result of the first evaluation of the term are factors that affect students' probability of failing subjects. Practical implications of these findings are discussed.

Keywords: performance; institutional research; multilevel regression analysis.

Resumen

Este estudio se centra en la relevancia de las variables organizacionales como posibles factores que influyen en el rendimiento académico de los estudiantes en una institución de educación superior chilena. Los datos se obtuvieron de los estudiantes que tomaron diferentes cursos entre los años 2013 y 2015. Se aplicó un diseño cuantitativo utilizando modelos multinivel de regresión logística para predecir las tasas de reprobación de los estudiantes en los cursos de matemáticas, física y química. Los resultados muestran que la programación de los horarios de clase y el resultado de la primera evaluación del semestre son factores que afectan la probabilidad de que los estudiantes no aprueben las asignaturas. Se discuten las implicaciones prácticas de estos hallazgos.

Palabras clave: rendimiento; investigación institucional, análisis de regresión multinivel.

In the context of the development of higher education institutions, a widely studied topic has been factors associated with academic performance. From studies focusing on the biographical factors of students to studies that emphasise the importance of pedagogical and psychological conditions, numerous researches have tried to elucidate which elements are linked with the achievement of a better academic performance (Chandler & Heffer, 2009; McKenzie & Schweitzer, 2001; Poropat,

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GESTIÓN DE LA INNOVACIÓN
EN EDUCACIÓN SUPERIOR
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2009; Richardson, Abraham and Bond, 2012; Thiele, Singleton, Pope & Stanistreet, 2016). From the above, studies coincide in pointing out that academic performance is the result of a multiplicity of components that act jointly and interactively (Bowles & Brindle 2017; Goldrick-Rab, 2010; Van Den Berg & Hofman 2005).

Within this context, one of the areas of study where there has been insufficient analysis is related to research that examines the importance of organisational variables and their influence on academic performance. These variables are those conditions of the educational environment that derive from the management of institutions where students conduct their educational activities. Organisational variables are of paramount importance when it comes to understanding the factors that determine academic performance as they can be directly intervened by higher education institution's administrators.

The above implies organisational knowledge generated from empirical evidence can lead to the definition of institutional practices at improving academic performance levels (Goldrick-Rab, 2010). Although the levels of achievement depend on a multiplicity of factors, where, for instance, it is known that the educational levels of a student's parents impact the performance that he/she may show in his/her studies (Stephens, Hamedani & Destin, 2014), the effects of these factors are more difficult to be modified through intended interventions. This situation precisely does not occur in the case of organisational variables.

Based on the above, this study aims to analyse the factors associated with the academic performance of higher education students with a special emphasis on those organisational variables that affect this phenomenon and that have the capacity to be managed. This is examined in a Chilean institution that enrols an important number of socially disadvantaged students representing their first family members to access higher education. To this effect, this study aimed to examine the effect of organisational variables on academic results considering an educational context where students face comparatively more challenges when adapting to tertiary education.

77

1. Literature review

1.1 Academic performance in higher education

Academic performance has always been one of the main concerns of both higher education researchers and practitioners. As stressed by Tinto (2012), one of the crosscutting objectives of every educational institution is related to avoiding dropout of students and increasing their academic performance. Among studies focused on academic performance, a central emphasis has been on identifying the role of a variety of variables that affect it. It is pointed out that academic performance is not just the result of a single ability but it is actually the result of a series of factors that act both on the student and the context where it develops (Van Den Berg & Hofman 2005). Among these factors, the focus has been on the role of three types of variables: psychosocial, sociodemographic and pedagogical.

In relation to *psychosocial factors*, it is argued that student achievement is associated with certain traits of the student's personality such as their self-regulatory strategies, psychological distress, motivation, anxiety and academic self-concept (Cvetkovski, Jorn & Mackinnon 2018; Richardson et al., 2012). Some of the most relevant authors of this trend are Albert Bandura and Barry Zimmerman, who have highlighted the importance of different individual processes associated with academic performance, such as self-discipline, self-efficacy, and self-regulation. For example, understanding self-efficacy as the individual's belief regarding his/her learning abilities, it is known that it influences both the performance that an individual exhibits in a task as well as their ability to learn those tasks where there is no clarity regarding the abilities required to carry them out (Bandura, 2012; Schunk & Zimmerman, 2011). Moreover, recent studies have shown that the effect of self-efficacy on academic results is higher among students with higher leadership skills (Dunbar, Dingel, Dame, Winchip & Petzold, 2018).

Concerning *sociodemographic factors*, when reviewing the literature exhaustive evidence is observed about the association between the socio-economic origin of students and their levels of integration to higher education institutions. For example, regarding the importance of parental education, Pascarella, Pierson, Wolniak and Terenzini (2004) point out that first-generation college students perform poorly and find greater obstacles in their institutions compared with those students whose parents also had access to higher education. Similarly, Thiele et al. (2016)

78

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Revista
GESTIÓN DE LA INNOVACIÓN
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found that British students coming from deprived areas perform less well that more affluent students and that different types of higher education schools predict different higher education results. Along the same lines, there are studies that highlight other sociodemographic factors that go beyond economic origin, such as age and gender, which would affect student performance (Díaz, 2008; Spencer, Steele & Quinn, 1999).

Finally, other studies have emphasised the importance of *pedagogical factors*. These are elements fundamentally associated with the different dimensions of teacher performance, from their professional development to their ability to communicate and their levels of motivation (Desimeone, 2009; Roorda, Koomen, Split & Oort, 2011). Within these studies, it is possible to highlight the pioneering research by Ramsden (1979) that examined the effects of the organisation of curricula, teaching and assessment on student learning. Similarly, other studies have pointed out the importance of elements such as didactic and curricular reorganisation, teaching from the perspective of the student, and types of evaluation practices in academic performance (Edgecombe, 2011; Jimerson & Haddock, 2015; Prosser & Trigwell, 2014).

79

1.2 The role of organisational variables

Having examined the three main types of factors that have been researched concerning their association with academic performance, it is necessary to broad this debate by discussing the role of organisational variables in this phenomenon.

As previously highlighted, this area lack of abundant research. When reviewing the literature it is not possible to find an articulated theoretical framework that allow defining particular variables to be included when examining the association between organisational features and academic performance. Rather, disjointed pieces of researches are found that discuss both the general relevance of this topic and the relationship between specific organisational factors and different measures of academic performance in different higher education contexts.

In relation to the relevance of *organisational factors*, once central argument is that it is a significant field of study based on the role that university management has played in the development of higher education institutions. In this regard, Clark (1986) highlights the complexity of

these types of institution given its high levels of diversity and fragmentation. They coordinate a series of issues associated with the various sections, levels, and hierarchies that comprise them; this generates the need to fully understand their basic structure in order to analyse their different problems and controversies.

In this context, *organisational variables*—also called institutional variables—can be defined as those college organisational attributes that condition the space where the teaching activity takes place; these are associated with the management activities of educational institutions (Calcagno, Bailey, Jenkins, Kienzl & Leinbach, 2008; Titus 2004). They are the structural and functional features of each institution, which include course schedules, college size, patterns of expenditure, the number of students in class, and the number of books in the library, among others; all of these are considered to impact students' academic performance (Montero, Palma, & Bermúdez, 2007; Titus, 2004).

In the same line, it is argued that the study of these types of variables is fundamental, especially when the use of the results of academic research is seen as an input for the development of higher education institutions. As Calcagno et al. (2008) point out, the study of the relationship between institutional factors and institutional effectiveness is essential as it permits higher education institutions to improve the academic success of their students. In other words, the study of the organisational factor/academic performance relationship generates the possibility of developing programmatic interventions within the associated academic institutions to improve student outcomes, such as modifying certain pedagogical strategies or reducing the size of sections of some subjects (Montero et al., 2007).

80

1.2.1 Organisational Variables and Academic Performance

With regard to the association between higher education institutions organizational features and students' academic performance, as it was beforehand stated, there is not a leading framework from which types of features to be considered when examining this link can be defined. There are more than anything isolated researches that have considered different types of organisational features when analysing students' performance. Among them, it is possible to differentiate between studies that have approached this issue from a more general perspective considering

sets of institutional variables and researches that have highlighted the importance of much more specific and manageable organisational factors regarding academic performance.

On more general studies, Goenner and Snaith (2003) argue that the student/teacher ratio and the percentage of full-time teachers play a significant role in explaining student graduation rates considering doctoral studies. Likewise, Wimshurst, Wortley, Bates and Allard (2006) found that the number of students enrolled, semester of course offering and year level are relevant factors associated to academic results among Australian students. In a study on Spanish students, Zabalandikoetxea and Merino (2013), conclude that there are five factors that rely on the administrative management affecting college students performance: the use of information and communication technologies (ICTs), the number of students in courses, the experience of teachers, the methodology used by the teacher, and the levels of attendance. Similarly, Calcagno et al. (2008) found a negative association in community college students between large institutional size, the proportion of party-time faculty and the presence of minority students and the probability of completing a degree or transferring to a bachelor's degree. Finally, Credé, Roch and Kieszczynka (2010) conducted a meta-analysis to examine the association between class attendance and college grades in American students. It was concluded that class attendance was a better predictor of college grades than any other known predictor of academic performance.

With respect to studies that observe the link between measures of academic performance and more specific and manageable organisational variables, Carrel, Maghakian and West (2011), determine that starting classes 50 minutes later in American air force students has a positive effect on student achievement. Similarly, Van den Berh and Hofman (2005) in a study in Dutch higher education institutions found that lower number of teaching periods in a course year and the lower number of subjects to be studied per period increase study success. Moreover, it is also found that higher achievement is obtained when a lecture-free period is planned prior to an examination, when it is possible to compensate for at least one failed examination and when students have partial examinations or can obtain bonus credits. Also, Henebry (1997) found that financial management students have a better chance of approving their courses when a class schedule meets more than once a week. Finally, Donnelly,

McCormack and Rimmer (2007), taking into account business schools students in Australia and Scotland, showed that a reduction of students' academic load generates in some contexts higher levels of attainment.

Based on the reviewed literature it can be observed that, even though there is not an articulated framework that permit to validate and prioritise the kind of organisational variables to be considered when predicting academic performance, the relevance of researching these themes can be justified. To this effect, this research proposed to investigate this issue in a higher education Chilean institution considering organisational variables that have been already employed in previous researches and innovating through the inclusion of other organisational indicators based on the available data of the institution where the study was conducted. Specifically, this study considered the importance in student performance of variables manageable by institutions pertaining to attendance levels, the hourly structure of the subjects and the amount of programmed assessment tasks.

2. Methodology

2.1. Context of Subjects, Population, and Data Collection

In the institution where the study was conducted, the subjects studying in the areas of mathematics, physics, and chemistry have the highest rates of student failure, Thus, an information registry was configured that allowed us to analyse organisational factors considering only these types of subjects. The database was used to obtain reliable and valid information on the academic results of each student who attended at least one subject in the indicated areas between the first semester of 2013 and the second semester of 2015. Additionally, only students who actually attended class were considered, which excluded records of students that did not sit for the exams during the semester. As students can haver records in several courses of the three examined areas, student's records were defined as the unit of analysis.

Based on the above, a universe of 374.312 records from 152.234 students in the areas of mathematics, physics, and chemistry who sat for at least one of the planned evaluations for the semester within the subject was set up. The distinction between the number of students and the number of registries is given by the fact that when considering

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GESTIÓN DE LA INNOVACIÓN
EN EDUCACIÓN SUPERIOR
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different subjects in this study, the same student can count on more than one registry, that is to say, a subject enrolled in the semester by a student. Regarding this study, an average of 2.24 records per student was considered. Having defined this data base, to calculate the final multilevel logistic regression models, only the records of students who sat for 100% of their evaluations during the semester were considered. By means of this procedure, 253.126 records were obtained from 120.351 students to define the definitive sample of this study.

The selected sample of students comprised 29% women and 71% men; 35.4% of these belonged to evening classes and the rest to day classes. In addition, the collected information is distributed within the three areas of knowledge addressed in the analysis. Students' academic performance results were obtained in 31 subjects from physics, 34 from chemistry, and 34 from mathematics, thereby totalling 99 subjects.

According to the records in the database, 42.1% of students have classes assigned on Mondays and 16% of them have a scheduled day where they must only attend the class of the subject of interest. Likewise, 37.7% of the records have at least one free period between subjects immediately before or after the analysed subject.

On average, students have about five evaluations assigned during the semester (s.d. = 1.0). In addition, first evaluation weights ranges from 3% to 50%, with an average of 20% (s.d. = 5.7%). Students achieved on average a grade of 4.7 (s.d. = 1), and, in particular, 16% of them obtained an insufficient grade on the latter.

2.2. Variables

The dependent variable of this study considers the performance of the student from the failure or passing of the subject during a certain semester. A binary measurement associated with the passing/failure of the subject is used instead of the continuous measurement of the final grade, since the latter does not reflect the difference in the final result that exists when it goes from a value of 3.9 to 4.0, corresponding to the value that determines passing [of the subject] on the measuring scale of 1.0 to 7.0 used by the institution studied.

In relation to the independent variables, thirteen independent variables were considered based on three main dimensions: a) organisational

characteristics that can be managed by the institution (4), b) student's performance behaviour (2), and c) control variables (7). All considered variables are presented in table I.

TABLE I
LISTING AND DESCRIPTION OF VARIABLES.

Dimension	Variable Name	Description	Level of Measurement
Dependent Variable	Academic performance	Measurement of student performance during a certain semester in a given subject. Take the value of 1 in case the student fails the subject and 0 otherwise.	Categorical (2 Categories)
Manageable Organizational Variables	Class on Monday	Indicates if the subject attended by the student has classes scheduled on Monday.	Categorical (2 Categories)
	Free periods	Indicates the number of free periods (45 Minutes) the student has before or/and after the examined class.	Continuous
	Only one class in one day	Indicates if the student has to set aside one day of the week exclusively for one a class in the day with a duration less or equal to three blocks.	Categorical (2 Categories)
	Weight of the first evaluation	Weight (in percentage) of the first evaluation of the semester in the analysed subject.	Continuous
Student Performance Variables	Percentage of attendance	Percentage of student attendance in the subject during the semester.	Continuous
	First evaluation grade	Grade that the student obtains in the first evaluation of the course (1 to 7 scale).	Continuous
Control Variables	Gender	Gender of the student.	Categorical (2 Categories)
	Years since secondary graduation	Number of years between graduation from secondary education and higher education enrolment.	Continuous
	Student seniority	It indicates whether the student is a freshman or a senior student	Categorical (2 Categories)
	Type of Study	Indicates if the student studies during daytime (8:00 to 19:00 hours) or during the evening (19:00 hours onwards).	Categorical (2 Categories)
	Math diagnostic test	Grade that the student obtains in the diagnostic test performed before enrolling in the institution (Scale 0 to 100).	Continuous
	Index of school vulnerability (IVE)	This index is used as an approximation of students' socioeconomic status. It indicates the proportion of vulnerable students of the school where students finished their secondary education.	Continuous
	Area of knowledge	Indicates whether the examined subject belongs to the area of Physics, Chemistry or Math.	Categorical (3 Categories)

Based upon the central objective of the study, it should be noted that the organisational variables defined in Table I were created based on characteristics associated with the student, given the subject that the student was taking. The importance of these variables is that they allow the institution to make decisions aimed at improving the academic performance of the student in order to pass the course taken.

2.3. Analysis

Data analysis began with a look at the variables with respect to their association with the academic performance of the student observed through his/her failure in a certain subject using the categorisations proposed in the descriptions of the variables in Table I.

From these initial analyses, a final set of data was generated to study the effect of organisational variables on academic performance. This last analysis, given the binary nature of the dependent variable considered (passing/failure of the student in a certain subject) was done through the construction of multilevel logistic regression models with logit linking function, which allows for the estimation of probability (Dobson & Barnett, 2008). Multilevel models were used in order to control for the fact that several students had multiple records in the data set. To this effect, multilevel models consider the hierarchical nature of the data when estimating the effects of the independent variables on approval rates as records are nested within students.

All analyses were conducted using the software STATA/IC 14.

3. Results

Table II shows the adjusted parameters based on the multilevel logistic regression model estimated from the organisational variables described in Table I. This model considers all variables with the exception of students attendance levels since based on previous variance inflation variable (VIF) analyses, it was detected that this variable present multi-colliniarity problems.

The final adjusted model was validated through the area under the ROC (receiver operating characteristic) curve, which allowed the measurement of their discrimination capacity corresponding to 87%.

This shows fitted model have a good discrimination capacity regarding academic performance between the students who fail the subject and those who do not fail. Additionally, a McKelvey and Zavoina pseudo R^2 of 0.41 was estimated, which shows that considered independent variables explain a relevant proportion of the dependent variable's variance.

TABLE II

MULTILEVEL LOGISTIC REGRESSION MODEL

Variables	B	SE B	EXP(B)
Free Periods	0.01 ***	0.00	1.01
Weight of the first evaluation	0.01 ***	0.00	1.01
Has classes on Monday	0.13 ***	0.01	1.14
Has only one class per day	0.09 ***	0.02	1.10
First Evaluation Grade	-0.98 ***	0.01	0.38
Type of Study (r/c Daytime)	-0.16 ***	0.02	0.86
Gender (r/c Female)	0.19 ***	0.02	1.21
Years since secondary graduation	-0.04 ***	0.00	0.96
Student seniority (r/c Senior)	0.16 ***	0.02	1.17
Math diagnostic test	-0.01 ***	0.00	0.99
IVE	0.21 ***	0.04	1.24
Area of knowledge (r/c Physics)			
Math	-0.02	0.02	0.98
Chemistry	0.17 ***	0.03	1.19
Constant	2.24	0.05	9.39

* $p < .10$. **$p < .05$. ***$p < .001$.

According to the organisational variables defined above, it is observed in table II that the fact that the student has either previous and/or posterior free period increases their odds of failing by 1% for a one-unit increase in the periods (OR: 1.01, 95% CI: 1.01, 1.02), holding every other variables at a fixed value. This effect is significant at the 1% level of significance. Regarding the weight of the first evaluation, the model shows that the odds of failure increase 1% when the weighting increase by 1% (OR: 1.01, 95% CI: 1.01,1.02), holding every other variables at a fixed value, being this effect significant at the 1% level of confidence.

Table II shows also that the fact of having classes scheduled on Monday and having only one class per day are significantly associated at the 1%

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level of significance with students' passing rates. In relation to the first association, if a student has classes scheduled on Monday increases his/her odds of failing the subject by 14% with respect to a student who does not have classes scheduled on Monday (OR: 1.14, 95% CI: 1.11, 1.17). With respect to the second association, it is observed that students who have days of the week with only one scheduled class increase their odds of failing by 10% versus those who do not have this condition (OR: 1.10, 95% CI: 1.06, 1.14).

In the case of the student's performance variables, it is observed that for every increase in one unit (scale 1 to 7) in the grade of the first evaluation there is 62% less chances of failure (OR: 0.38, 95% CI: 0.37, 0.38), holding every other variables at fixed value.

With regard to control variables, it can be inferred that evening, women and senior students are less likely to fail the examined courses. Likewise, it is observed that students that accessed higher education at a later stage, that have higher scores in the math diagnostic test and that graduated from less vulnerable high schools have better academic results.

4. Conclusions and recommendations

Understanding the association between organisational factors and academic results emerges as a crucial challenge within the field of higher education as these variables can be controlled and managed by both educational institutions authorities and public policy makers in order to improve students' performance (Calcagno et al., 2008). In this context, this study provides empirical evidence suggesting that, for students in mathematics, physics, and chemistry subjects at a Chilean higher education institution, organisational factors have an important effect on academic performance.

In relation to the specific variables considered in this study, results showed that the way in which the institutions define the scheduling of subjects affects student's academic results. In this respect, it is observed that those students who have more free periods between classes have greater opportunities to fail their subjects. Moreover, results suggested that scheduling class modules for the examined subjects on Monday and as the only class of the day reduce students' odds of passing these subjects. When contrasting these results with the literature about the

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effect of scheduling variables, mixed results are found. Even though the relevance of these variables is recognised, associations found are not always in the same direction as what was examined in this study. For example, Berh and Hofman (2005) argue that having a free-period planned before an evaluation improve students' results and Carrel et al. (2011) found that delaying early-morning classes positively affects academic performance. In this sense, it can be concluded that institutions have to be aware of the general importance of scheduling variables on students' results. However, they must know that the direction and specificities of these relationships are strongly defined by their specific educational contexts.

In sum, these results show that the examined organisational variables are significantly associated to students' academic results in the considered institution for this study, which reinforce the literature advocating for a more relevant role of these types of factors when explaining academic achievement. Furthermore, from these results it is also concluded that the way organisational variables affect students' performance in higher education institutions seems to be importantly influenced by the specific social context where this association takes place. Thus, it is recommended that the effect of organisational variables in academic results should to be always examined considering specific contextual attributes that interact this relationship, such a students' socio-economic status or their levels of academic readiness for tertiary education.

In the case of the context of the present study, it was conducted in a non-selective institution that enrols an important number of socially disadvantaged students that previously have not had the chance to enter postsecondary education. These students were normally educated in low-quality secondary schools, have parents with low-education levels and many of them have the need to work during their studies, all situations that limit their academic success (Díaz, 2008; Pascarella, Pierson, Wolniak & Terenzini, 2004). To this effect, these findings permit to hypothesise that the magnitude and direction of observed associations between organisational variables and academic results in this study is related to these students' attributes that limit academic success. For example, having found that organisational attributes producing waste of time are negatively associated to academic results could be linked to the fact that time is a much scarcer resource for socially deprived

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groups. In the same way, these results allow the suggestion that managing organisational variables can be a comparatively more relevant asset for institutions enrolling less prepared students, as this facilitates their academic integration.

In order to test these ideas, however, further studies would need to be conducted. First, the link between academic results and organisational variables could be examined separately by socio-economic groups using quantitative methods. Likewise, these issues could be also studied through qualitative methods that address why students have a greater or lesser propensity to fail a subject given certain organisational conditions considering how specific students' characteristics interacts with these phenomenon. For example, it could be researched the reasons why free periods before or after their class schedule affect their results taking into account the association between these two variables and students' employment situation.

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90

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92