

# Retention in the School of Engineering of the Universidad Pontificia Bolivariana, Medellín-Colombia

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**CONTEXT** This article shares the experience of a persistence (student retention) program articulated with the Academic Advisory of the School of Engineering in the Pontifical Bolivarian University (UPB) - Medellín, through the case study "Ser Pilo Paga", including the educational lag of those favored by the program and the main strategies to mitigate it.

**PURPOSE** Identify the main factors leading to dropout in engineering students.

**APPROACH** Documentation regarding the main influential factors for dropouts in Colombia and worldwide, and strategies to mitigate it in the UPB.

**RESULTS** Articulating the different efforts made in higher education institutions to control lag and dropout is fundamental. Likewise, success indicators that favor a higher quality in education must be generated. It must be noted that this is the first article regarding the Ser Pilo Paga program in the UPB. This suggests that there is not sufficient data concerning students nor strategy results. These will be showed in a second version of this paper.

**CONCLUSIONS** Efforts must be made answering the different problems that lead to student dropout and lag, so that they are not merely regarded as academical, but rather multidimensional issues.

**KEYWORDS** Dropout; Student retention; higher education; attrition.

## Introduction

According to statistics from the Ministry of National Education (MEN), approximately half of the students entering a higher education institution fail to complete their academic cycle and obtain their degree (MEN, 2009). According to statistics provided by the System for the Prevention of Higher Education Dropout (SPADIES), 48.47% of students who entered higher education in the first half of 2000 did not reach the 10th semester, and neither did 57.2% of those who entered during the first half of 2008 (SPADIES, 2014). Sultana, Khan & Abbas (2017) argue that, even in the most developed European countries, engineering students drop out at a rate of 40% to 50% during their first year, and they may even reach 80% in some engineering disciplines. Paura & Arhipova (2016) studied the reasons for dropout in the Latvian Agriculture University and found similar rates in engineering faculties between 2012 and 2014 (47.6%). Parkin & Baldwin's (2009) results are much lower than those typically found, ranging between 10% and 20% of higher education students who fail to obtain their degree. Generally, Engineering, Architecture and Fine Arts have the highest attrition rates, reaching 50%. Engineering programs show high dropout rates both in Latin America and Colombia (MEN, 2009).

The School of Engineering of the Pontifical Bolivarian University (UPB) - Medellín created a new project called "Academic Advisory" in 2015 as a result of the massive enrollment of students in that year. It was based on a National Government strategy (Ser Pilo Paga) which sought to give access to high-quality higher education institutions to high performing students with scarce economic resources. From that historical moment, different strategies - academic, socioeconomic, institutional, etc.- have been set forth to accompany students.

This article presents a particularity in higher education since the government's initiative, the program "Ser Pilo Paga", and its implementation through the Student Retention Program and Academic Advisory of the School of Engineering for the mitigation of lag and student dropout at the UPB.

## LITERATURE REVISION

Both national and international literature was reviewed, since college student dropout is a concern in Latin America as well as worldwide.

Several authors define student dropout as the definitive abandonment of the institution after interrupting studies for two consecutive periods. Changing programs within the institution cannot be considered as dropping out, as these are simple cases of intra-institutional mobility (SPADIES, 2014; MEN, 2009).

Among the main factors identified in the literature as determining for student dropout are individual, institutional, socioeconomic and academic factors.

### Individual Factors

Individual factors are related to essential elements such as the career choice (influenced in many cases by family environment, social groups, social prestige of certain professions, etc.), the student's analysis of his or her university life, the individual's perspective on a chosen career, expectations of success, failure intolerance, sex (dropout risk decreases in female groups), age, and others (Fishbein & Ajzen (1975); Attinasi (1986); Ethington (1990); Franco (1991), cited by SPADIES (2014); Castaño et al., 2004; MEN, 2009; SPADIES (2014)).

## **Institutional Factors**

Different authors confirm the importance of student integration to campus life and their accompaniment in different processes. Academic records -such as previous academic performance and the institution attended- are relevant to attrition rates. Students who studied in private schools seem to be less likely to drop out. Institution commitment in student training is key since the beginning of the programs in order to create a sense of belonging and integrate the student in their environment. Welfare programs are also considered as an influential factor in student dropout (Ethington (1990); Spady, 1970; Tinto, 1975; Cabrera, Nora & Castañeda, (1993); Gresia, Porto & Ripani (2002)).

## **Academic Factors**

Several authors confirm that students drop out more frequently during the first semesters of their career. This is affected by their academic performance in high school, academic integration and academic performance in general when entering college. Interaction with teachers and other students is also important, as it has been verified that those who interact more have a lower risk of dropping out. Among the academic factors that increase the risk of dropping out, it is possible to identify flexible curricula, pedagogical modalities, repetition rate, learning styles, time management, and others (Bank, Slavings, & Biddle,(1990); Castaño et al., (2004); MEN, (2009); SPADIES, (2014); Sultana, Khan & Abbas (2017); Sittichai, (2012); Acevedo, Torres & Tirado, (2015); Paura & Archipova, (2016); lam-On & Boongoen (2017)).

## **Socioeconomic Factors**

The literature points to socioeconomic factors such as: parents' educational level, for the higher the parents' education is, there appears to be a lower dropout risk for the student; family income, for a lower income represents a higher dropout risk; work, for students who have jobs have a higher dropout risk; career preference, for being enrolled in a program that is not of their preference creates a higher dropout risk; adaptation to the institution regarding personal socio-economic situation; among others (Acevedo, Torres & Tirado, (2015); Sittichai, (2012); Ministerio de Educación, (2009); SPADIES, (2014)).

Furthermore, these factors and dropout per se affect the institution's reputation, as well as the relationship of families with institutions, not to mention that national economic inequalities may increase (Raviv & Bar-Am (2014); MEN, (2009); Castaño et al., (2004)).

## **Methodology**

The main objective of this article was to share the experience gathered from the Student Retention Program from the UPB - Medellín in the School of Engineering and revise similar experiences nationally and internationally, through:

- Reviewing literature on the main causes worldwide for student dropout and strategies to mitigate it
- Documenting the Student Retention Program in the UPB, considering its evolution in the institution and the articulation with the School of Engineering for the mitigation of student dropout with its different programs
- Identifying the root causes of student dropout
- Determining strategies for the mitigation of student dropout

# Student Retention Program in the Pontifical Bolivarian University (UPB) - Medellín

The Student Retention Program in the UPB - Medellín, its evolution, support team, strategies, and the particular case of dropout management at the School of Engineering are presented below.

## Description of the Student Retention Program in the UPB - Medellín

The Student Retention Program in the UPB - Medellín first started in specific areas. By the year 2010, a group that began to think about the persistence of good students in a centralized way was created. In 2015, the program became official and was led by the Pastoral Vice-Ministry. Finally, it became part of the Academic Vice-Ministry in 2016.

The program aims to strengthen the integral accompaniment of undergraduate students through the implementation of strategies that increase their persistence and success. Some of the subprocesses that are managed from the Student Retention Program in the UPB are: i) school-university articulation, through integrated curricula, academic internships, professional orientation, among others; ii) adjustment to university life, with psycho-pedagogical, psychosocial and economic support; iii) preparation for professional life; and iv) return to the UPB.

Student retention or persistence is understood as the scenario that shows the decision of the college student to carry out the program offered by the university, favored by institutional, academic, psychosocial and economic conditions. In these conditions, multiple opportunities of accompaniment to the student have been detected, given the high risk factor that they represent in student dropout as it was observed in the literature review.

Some of the strategies generated in the face of risk factors for the community in general are shown in Table 1.

**Table 1. Strategies according to risk factors**

Risk factor	Strategy
Academic	Professional orientation Intervention in most failed or dropped-out courses Academic follow-up Workshops for learning, psycho-pedagogical accompaniment, others

Psychosocial	<p>Psychological and spiritual counseling</p> <p>Programs for the detection and management of mental health risk factors in the university community</p> <p>Programs to strengthen the student's abilities and resources in their training process</p>
Economic	<p>Solidary supports (food, transport, photocopies, materials)</p> <p>Follow-up and orientation in scholarships and discounts</p> <p>Case analysis of calamitous situations for financial aid and others</p>
Institutional	<p>Strengthening and positioning of retention program</p> <p>Improvement of the quality of data related to information on attrition and institutional persistence</p> <p>Articulate work among areas related to students</p>

Source: Own elaboration.

### **“Ser Pilo Paga” Program**

The "Ser Pilo Paga" program was conceived when a doctoral thesis confirmed that, in Colombia, around 17,000 youths of strata 1, 2 and 3 with excellent results in the Saber 11<sup>o</sup> tests, but with low economic resources, could not access high-quality higher education. Based on this analysis and within the "Agreement for the Superior 2034" framework, the National Government announced the "Ser Pilo Paga" program in order to give these young people from different regions of the national territory access to accredited universities, seeking to narrow educational gaps (<http://aprende.colombiaaprende.edu.co/es/pilopaga/91610>):

This program grants 100% subsidized credits. The condition for acquiring them is the graduation of the student from the academic program in which he or she was approved. The requirements to apply to this program are the following (<http://aprende.colombiaaprende.edu.co/es/pilopaga/91610>):

- Being Colombian
- Having a score in the Saber 11<sup>o</sup> test equal or higher to: 310 (Ser Pilo Paga 1); 318 (Being Pilo Paga 2); 342 (Ser Pilo Paga 3)

- Having attended and approved the 11th grade during call year (this only applies only for SPP 2 and SPP 3)
- Being admitted to an academic program, in face-to-face mode, offered at a higher education institution with high-quality accreditation (or in the process of renewing accreditation)
- Being registered in the Sisbén database within the due date and with the score established in each of the calls. In the case of being indigenous, students must be in the Ministry of the Interior database within time frames established by each call.

Each call has different regulations. However, some remain the same, such as receiving 100% subsidized credit if the degree is obtained in the expected time, having the right to two postponements periods throughout the career, having at least one transfer opportunity with due justification, among others.

### **Ser Pilo Paga in the Pontifical Bolivarian University (UPB) - Medellín**

Since the Pontifical Bolivarian University is one of the most prestigious accredited universities in the country, when this government program was started in 2015 there was an income of approximately 600 "Pilos". In 2016, there were 650 and, in 2017, 400. As much as 51% of them chose the different programs offered in the School of Engineering (Aeronautics, Industrial, Administrative, Chemical, Mechanical, Electrical, Electronics, Agroindustrial, Textile, Nanotechnology, Telecommunications, Design of Digital Entertainment, and Systems and Computing). The UPB was the higher education institution most requested by the beneficiaries of the program in Antioquia.

The scenario was quite positive as it fulfilled its main objective, yet some neuralgic points to be adjusted were identified in order to better achieve goals as well as mitigate dropout rates:

- Program selection without previously reviewing said program
- Difficulties adjusting to the city
- Failure intolerance
- Admission to college at an early age
- Issues with basic skills such as reading comprehension
- Economic conditions that limit the training process of some favored students
- Basic competences in mathematics

The University and, especially, the School of Engineering have generated strategies to accompany students in their training process, e.g. the creation and strengthening of the Student Retention Program for the entire university, and the Academic Advisory from the School of Engineering, directly articulated with the Student Retention Program, and through which the different School strategies are intended to be managed.

The aforementioned factors have been mitigated as much as possible with the program, which is the central axis for the accompaniment and follow-up of all those activities in favor of the student, as well as with College Welfare through psychological and economic support programs (such as food aid and transport aid), and time management and study technique workshops, and the Academic Advisory through direct counseling in the management of the curriculum and redirecting, whenever it is considered pertinent.

Several accompanying strategies have been implemented prior to the Student Retention Program and the Academic Advisory in the School of Engineering, both in the area and the physics center, since 2008. One of the most successful projects within students was the creation and ideation of "useless machines", also known as "Goldemberg Machines", with

which students develop research skills and understand physics in a more dynamic way. Similarly, as an initiative of some science teachers, the Academic Action and Intervention Group (GAIA) was created. It aims to provide accompanying resources, strengthen and generate basic mathematical skills, specially for those students diagnosed with particular difficulties for understanding concepts or mathematical algorithms. It helps them acquire basic skills that improve their academic performance through personalized attention (López, Cardozo, Posada, & Cano, 2015).

Through the joint efforts of the Student Retention Program and the Academic Advisory of the School of Engineering, dropout risk factors, not too different from those found in the literature, were identified and can be classified in four major groups: individual, socioeconomic, academic and institutional.

The case of the "Ser Pilo Paga" Program is presented and the opportunities it has provided to the institution in the analysis of student dropout and lag. As previously stated, the School of Engineering has received approximately 51% of the "Pilots" who have entered the institution since the year 2015.

22% of the students that joined the university since 2015 have dropped out, while 50% of them have lagged behind. The students who attended the meetings convened in October of this year, which were 50% of those invited, expressed that the main reasons for academic lag are inadequate study methods, low previous academic competences, time management difficulties, low motivation and academic commitment, academic stress, and others.

The student dropout rate in the "Ser Pilo Paga" Program does not correspond to the numbers typically found in literature. Possibly due to the nature of the program, students focus on completing their degrees in order to cancel 100% of the credit. Nevertheless, lag percentage is higher than 50%. Students who started in 2015 and 2016 have a delay of two to four semesters. The main weaknesses within the academic factor were: lack of previous knowledge, critical readings and, in addition, lack of student motivation. As a consequence, there was considerable difficulty in overcoming the basic sciences. Table 2 shows the courses that are most repeated.

**Table 2. Most repeated courses**

Course Department	Course
CENTER FOR BASIC SCIENCES	Differential calculus
	Analytic geometry
	Integral calculus
	Linear algebra
	Mechanic physics
	Basic mathematics
	Humanism and citizen culture
	Electricity and magnetism

	Geometry and trigonometry
	Basic chemistry and laboratory
	Engineering drawing
	Vector calculation
	Vector geometry
	Differential equations
	Mechanical and lab foundations
	Discrete mathematics
CHEMICAL ENGINEERING	Statistics and experi design
	Chemistry fundamentals
CENTER FOR HUMANITIES	General ethics
	Basic christology
LANGUAGE AND CULTURE	Language and culture (education)

Source: Own elaboration.

It is important to note that, from the courses shown in Table 2, approximately 76% of them are basic sciences. From this percentage, 32% of the courses belong to the first semester (Differential Calculus and Analytical Geometry), 24% to the second semester (Integral Calculus and Linear Algebra), and 7% to the third semester (Vector Calculus and Differential Equations). That is, approximately 63% of most failed basic science courses take place within the first three semesters of an engineer's training career. This fact corroborated what existing literature shows.

Analysis carried out by the System for Dropout Prevention in Higher Education (SPADIES) have identified the first four semesters as the period with the highest dropout numbers. In the case of Colombia, the main factors associated with this phenomenon are related to low academic entry skills, economic difficulties and aspects related to socio-occupational orientation and adjustment to the university environment (MEN, 2015).

Academic preparation is one of the most powerful predictors of student persistence in higher education. Low-quality secondary schools that tend disadvantaged populations fail to properly prepare youths for higher level education challenges. Therefore, they are unlikely to earn an undergraduate degree. Educational initiatives that seek to compensate this aim to increase the amount of students that can enter and remain in higher education systems (Savitz-Romer et al., 2010). Although this is ideal, it is important to consider the issue of inclusion and understand attrition in a holistic way. Therefore, from the School of Engineering through the Academic Advisory and in articulation with the University's Student



Retention Program, some strategies have been proposed to mitigate lag and possible dropout of the "Pilos" (Table 3).

**Table 3. Risk factors and strategies to mitigate student lag and dropout.**

RISK FACTORS	Strategy to mitigate lag and dropout
<b>Low access to vocational guidance processes since middle school:</b> students' vocational choice is mainly guided by a teacher or a family member, according to the skills they saw in them	Provide vocational guidance tests online at the UPB Portal for students interested in entering the institution
	Carry out a Vocational Orientation process for all potential beneficiaries of the "Ser Pilo Paga" program who will join the UPB
<b>Students with conceptual gaps since middle school:</b> 85% of students report academic difficulties (basic science)	Perform a diagnostic and leveling process in critical reading and basic math for all students entering the University. This strategy was designed for the School of Engineering in the first three semesters, offering courses with the basic knowledge required to tackle the corresponding courses at each level.
	Strengthen academic accompaniment strategies (Monitoring, Tutoring, GAIA, Academic Support to Student, among others)
<b>Adaptation difficulties:</b> Some students come from municipalities or neighborhoods that have very different cultures and social dynamics from those experienced in the city of Medellín. Likewise, many young people have spent their whole lives with their families and when they move from remote regions, they must learn to live alone and take on new responsibilities, i.e. money management	Broaden guidance day objectives in order to include informative strategies regarding campus and city life and facilitate the adjustment of new students and, especially, foreigners: they will become more familiar to college early on and, thus, favor their adaptation and the search for timely support.
	Provide information about access routes, transportation, nearby neighborhoods where they can look for student residences, among other important issues regarding the city since the admission

Source: Own elaboration.

Most of the strategies proposed above correspond to the Prevention Phase, during which the UPB - Medellín and, in general, the Colombian educational system must strengthen processes of articulation between schools and universities, and emphasize strategies of academic and integral growth during the First Year. According to the literature, this is the key point to prevent dropout and promote persistence and successful egresses.

The financial investment in these strategies is compensated by the persistence of each student, for having to invest in remedial strategies or late intervention in students who drop out is more expensive.

Finally, it is important to note that this article is the first documentation of the “Ser Pilo Paga” Program in the UPB. This implies that there is no sufficient data regarding students nor strategy results. These will be addressed in a following version of this research.

## CONCLUSIONS

The main reasons behind student lag mentioned by students that belong to the “Ser Pilo Paga” Program in the UPB were: inadequate study methods, low previous academic competences, time management difficulties, low motivation and academic commitment, stress, adjustment difficulties, economic hardship, among others.

Efforts must be made answering the different problems that lead to student dropout and lag, so that they are not merely regarded as academical, but rather multidimensional issues. Some of the efforts that must be considered in the academic factor are leveling courses, transition programs, monitoring, tutoring, support courses in different modalities and the use of different teaching and learning methodologies.

Continuing programs, academic counseling, and other support schemes in student training should join efforts in order to provide better student orientation. Individual efforts have been registered as failing to achieve the goal and rather losing resources. Furthermore, it is key that the actions are preventive and planned according to each context.

Institutions of higher education must work on strategies to create a sense of belonging in students, since it has been proved as a key element in persistence.

It is important that universities design student retention success indicators, without compromising their standards.

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