

Retrospective Study of Generational Cohorts to Diagnose Terminal Efficiency in Industrial Engineering Students

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Abstract. Currently, in The Industrial Engineering degree at the Tecnológico Nacional de México / Instituto Tecnológico de Apizaco its enrollment has increased, however, in each generation, there is still a gap between the number of students who enter compared to the number of students who manage to obtain their degree. The study and monitoring of the terminal efficiency in each generation constitutes a very valuable source of information that, when systematized, is capable of strengthening educational planning in the search to improve the quality and relevance of educational services, thereby achieving a more inclusive higher education. The objective of this study is to identify the behavior of the academic performance of the generational cohorts of 2015-2020, 2016-2021, 2017-2022, 2018-2023 in terms of dropout, graduation, obtention of a degree, and gender.

For the analysis of these behaviors, a retrospective, quantitative, descriptive approach was used, individually in the existing records (Grade notebooks) of each generation, provided by the Department of School Services. Subsequently, the object of this study is examined, characterizing the students for each generational cohort based on the parameters already mentioned. The study of a group of students by generational cohort allows to diagnose their academic progress. The results obtained in the Parameter Without Degrees indicate that a large proportion of students fail to graduate. In the Graduates Parameter, the values obtained show that the terminal efficiency of the students is relatively low. There is a high level of dropout in some generational cohorts. This is probably an area of concern and intervention to remedy the problem.

Keywords: generational cohort, diagnosis, terminal efficiency, retrospective analysis

Introduction

In the academic dynamics and professional environment of Industrial Engineering, understanding generational cohorts of students has become a crucial area of interest to adapt teaching methods and improve educational outcomes. Generational cohorts, or groups of students entering in the same period and exposed to similar sociocultural contexts, present distinctive characteristics, values and skills that influence their university experience and professional development.

Industrial engineering, as a discipline focused on the optimization of systems and processes, benefits significantly from a generational perspective and is taught at the Tecnológico Nacional de México / Instituto Tecnológico de Apizaco, based on the current Study Plan IIND-2010-227, in which the subjects of the generic structure, the specialty module and the professional residency can be taken from 10 to 12 semesters. However, current cohorts, influenced by technological advances, social changes and new labor expectations, require an educational approach that not only transmits technical knowledge, but also prepares students to face contemporary and future challenges. In addition to the above, it identifies how generational differences impact the way in which students approach their academic and

professional training, and how these differences can be leveraged to improve educational quality and preparation for the labor market.

The purpose of this study is to identify patterns and trends in order to understand generational differences that will allow us to determine the areas of opportunity for the benefit of students. This will provide guidelines for understanding the reasons behind variations in completion efficiency and generate strategies at a given time that address the specific needs of each generational cohort.

Literature Review

The study of generational cohorts using a retrospective and quantitative methodology offers a valuable perspective on how historical and cultural contexts influence students' academic performance. This analysis allows the adaptation of educational practices, as well as improving the understanding of students' needs, thus contributing to a more effective and relevant training in the Industrial Engineering degree. A solid foundation for the study is provided by key concepts of generational theory, research methodology and academic analysis.

Generational cohorts are defined as groups of individuals who are born and raised in a similar historical period, sharing specific experiences and sociocultural contexts (Gadames, 2022). In the academic field, these cohorts reflect the common characteristics and values that influence student behavior and performance. These cohorts are differentiated by aspects such as technological advances, changes in the labor market, and transformations in social and educational expectations.

According to Bravo, Illescas & Peña (2020), the academic trajectory is the result of the curricular path that a student takes, taking into account the duration of the professional career, the regularity of the studies and the graduation. Within these definitions, two types of trajectory are distinguished: the one planned in the curriculum of the degree and which is the ideal one, and a second trajectory which is the one that the student actually completes.

Academic trajectories along with generation theory in education are considered as an object of research in higher education institutions. Based on the premise that students from different generations may have different motivations, learning styles and attitudes towards education due to differences in their historical and cultural contexts. For example, cohorts that grew up with digital technology may show greater mastery of technological tools and a different approach towards learning compared to previous cohorts (Zandomeni & Canale, 2010).

The study of research methodologies in education, determines the retrospective approach in research, which implies the analysis of historical data to examine past events and their effects on the present (Cabrera et al. 2006). In the context of the study of generational cohorts, the orientation is to investigate how the characteristics and experiences of different cohorts have influenced academic performance over time. The use of academic records, such as grade notebook, facilitates the recovery of historical data that reflect the performance and evolution of students across cohorts.

The research objective of Zamora (2021) is to know the reasons why a first-year student can become an early dropout; studying the particular case of the National University. He uses a quantitative exploratory, non-experimental and correlational approach. The participants were 158 students from the 2014 cohort, who did not report enrollment in the first cycle of 2015, to whom a questionnaire with 25 questions was applied. Through an exploratory factor analysis, it is possible to determine that the variables associated with school dropout respond to factors of type (1) academic and student environment, represented by grades; (2) motivational, in which variables such as mood, duration of the degree, lack of guidance, among others, stand out; (3) economic-family, associated with the lack of a scholarship, family problems or change in marital status; and (4) vocational, related to variables such as lack of interest and perception

of poor usefulness of the degree selected as a first option. In addition, dropout rates were higher among students in stratum 3, that is, those from schools with fewer educational opportunities and from the most vulnerable social sectors.

Descriptive analysis is a methodology that focuses on summarizing and describing the characteristics of data without inferring about possible causal relationships. In the study of generational cohorts, descriptive analysis provides a detailed understanding of patterns and trends in academic performance. Measures of central tendency (such as means and medians) and measures of dispersion (such as standard deviations) are used to describe the variations and distributions of grades and other academic indicators (Morales, 2022).

Research provides valid information and accurate knowledge about education for the purpose of making informed decisions. Since research systematically describes or measures phenomena, it is a better source of knowledge than individual experiences and opinions, tradition, or mere intuition. Some studies are abstract and provide general information about common educational practices and policies. This type of research influences the way one thinks about education. Other research provides detailed information about specific actions in a specific setting, such as a school, classroom, or program. It can also be used immediately in planning, developing, or improving a particular practice (McMillan & Schumacher, 2005).

The academic trajectory refers to the students' school history, including admission and graduation until they reach the grade, and in case of difficulties, it includes their lag or dropout. Academic behavior is the way students act in educational institutions, a reflection of their emotions, ideas, feelings and opinions, which includes academic performance, passing or failing, dropping out of school and changing degrees (Rangel, 2019, cited by Santillán, López, & Barajas, 2023).

In higher education, there are some problems that lead to the success or failure of students. One of them is desertion, which implies the disaffiliation of the student from the system, voluntarily or forcibly, definitively or temporarily, and can occur in relation to a particular degree or institution, as well as to the system as a whole (Tinto, 2017).

In order to evaluate the results of a process, that is, its performance, it is necessary to define the main indicators that allow identifying its behavior - known as critical process metrics - and, through the use of statistics and other quantitative techniques, determine deviations to correct them, as well as to improve continuously. The importance of continuous process improvement is due to the fact that effective and efficient institutional management implies monitoring the operation of the processes and verifying that they are obtaining the results for which they were designed and, in this way, avoiding their deterioration (Secretaría de la Función Pública, 2023).

Methodology

This study uses a retrospective, quantitative and descriptive methodology to analyze the generational cohorts of Industrial Engineering students using data from existing records, specifically the academic transcripts. This ensures a rigorous and systematic analysis of the historical exploration of students, providing a clear view of how generational cohorts have influenced academic performance. The methodology is structured in several key stages to ensure a concrete and detailed evaluation of the historical data:

Compilation. The Department of School Services was asked for the list of students by generational cohort 2013-2018, 2014-2019, 2015-2020, 2016-2021, 2017-2022 and 2018-2023.

Setting Parameters. Identification of parameters (dropout, failure, terminal efficiency by generational cohort and by gender) to be studied; as well as trends in academic performance of different generational cohorts. Describing the evolution in academic and performance characteristics during each determined period of time.

Selection and Data Compilation

Selection. Generational cohorts of Industrial Engineering students who have completed their degree in a defined period are selected. The cohorts are defined by their year of admission to the degree and all cohorts available in the Grade notebooks records are included.

Data Compilation. The Grade notebooks records of each student within the selected cohorts are accessed. These records contain relevant information such as:

- Grades. Scores obtained in each course.
- Other Courses. Courses required for professional training such as: Complementary Activities, Social Service and Professional Residencies.
- Academic History. Enrolment dates, dropouts, course repetitions and obtention of the degree. Therefore, for the present diagnostic study, only data already considered as parameters of: dropout, failure, terminal efficiency and the sex of each student are considered.

Data Processing and Analysis

Data Preparation. The extracted data is analyzed and validated to ensure its accuracy and consistency. This includes removing duplicates and correcting errors.

Quantitative Analysis. The most in-depth and nuanced analysis of the academic situation of students for each generational cohort in relation to: graduation rate, dropout rate and no degree. Relevant information, acquired at the time of coding the average data for each generational cohort. These are entered into the PSPP statistical software to obtain the mean and average, in order to summarize the information on a set of data in a single value, thus facilitating its interpretation. To perform the data analysis, descriptive statistical techniques are used, such as:

- Measures of Central Tendency. Averages, medians, and modes of grades (Triola, 2018) (Mertler & Vannatta, 2016).
- Measures of Dispersion. Analysis of data variability with standard deviation is used to visualize how percentages vary within each cohort. (Mertler & Vannatta, 2016). A low standard deviation indicates that the data is similar, while a high deviation suggests significant differences between students. (Manrique, 2006). Knowing the standard deviation allows us to detect outliers that can influence the interpretation of the data. In this way, it can reveal exceptional cases that need attention. In the performance assessment of each generational cohort, the range of grades provides an insight into the dispersion of student performance. It is very useful for identifying whether there are students who deviate significantly from the average. (Johnson, 2012).
- Trend Analysis. This involves assessing changes in academic performance across different generational cohorts. Studying this data across different generational cohorts allows for observing trends and patterns in completion, dropout, and obtention of the degree, which can help improve educational strategies.
- Cohort Comparison. Comparison of academic characteristics across different cohorts to identify patterns of change.

To perform the quantitative analysis of the above parameters, Excel 2016 spreadsheets are used for the data of each generational cohort. For statistical purposes, the data are coded and analyzed using the Program for Statistical Analysis of Sampled Data (PSPP) version 14.0. This consisted of analyzing each generational cohort, determining each of the dependent parameters.

Results

The results are presented in the context of generational characteristics (Table 1), identifying key trends with possible causes of variations in academic performance.

Table 1. Admission, graduation rate, dropout rate, graduation rate and dropout rate by gender of students by generational cohort of study

Generational Cohort	Number of Grade notebooks (Men-Women)	Dropout Rate	Graduates Rate	Percentage without a Degree	Sex	
					Men	Women
Cohort A-D 2013	104 (M=79, W=25)	46.15	53.85	100.00	32	10
Cohort E-J 2014	1 (excluded)	0.00	0.00	100.00	0	0
Cohort A-D 2014	80 (M=53, W=27)	47.50	52.50	100.00	24	12
Cohort E-J 2015	44 (M=26, W=18)	59.09	40.91	40.91	16	10
Cohort A-D 2015	141 (M=102, W=39)	43.26	56.74	100.00	44	17
Cohort E-J 2016	24 (M=17, W=7)	54.17	45.83	90.91	8	3
Cohort A-D 2016	149 (M=95, W=54)	51.01	48.99	61.64	41	23
Cohort E-J 2017	24 (M=13, W=11)	50.00	50.00	87.50	9	8
Cohort A-D 2017	142 (M=86, W=56)	51.41	48.59	100.00	44	29
Cohort A-D 2018	158 (M=112, W=46)	89.00	33.00	100.00	63	26

The data presented in Table 1 correspond to the information provided by the School Services Department, where each student's Grade notebooks was scanned, extracting relevant information from each of them, thus forming the initial data for the study. This was the most thorough and detailed task, when scanning each Grade notebooks and each generational cohort to obtain the parameters: percentage of students who entered; dropout rate; percentage without a degree and the quantitative analysis of dropout by sex.

To calculate the Measure of Central Tendency, which is the average rate of dropouts compared to the average rate of graduates, a comparative graph of both parameters was generated, as shown in Figure 1.

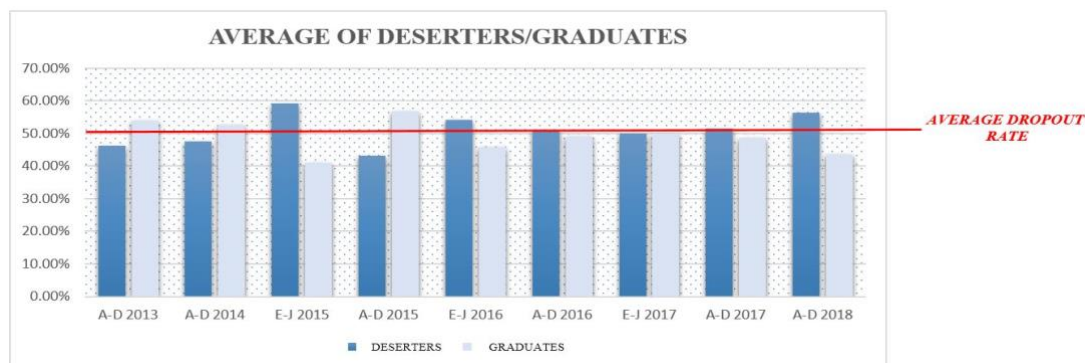


Figure 1. Rate of graduates, rate of dropouts and average number of dropouts by generational cohort

Based on the above rates and to facilitate the interpretation of the graduates, the sets of values of each generational cohort are summarized in a single value, which is the average percentage of dropouts. Thus, the average percentage of dropouts calculated is 50.99%, compared to the average percentage of graduates, which is 49.01%. In Figure 2, it is visibly noticeable how, on average, all generational cohorts had a higher dropout rate compared to the students who graduated in each cohort.

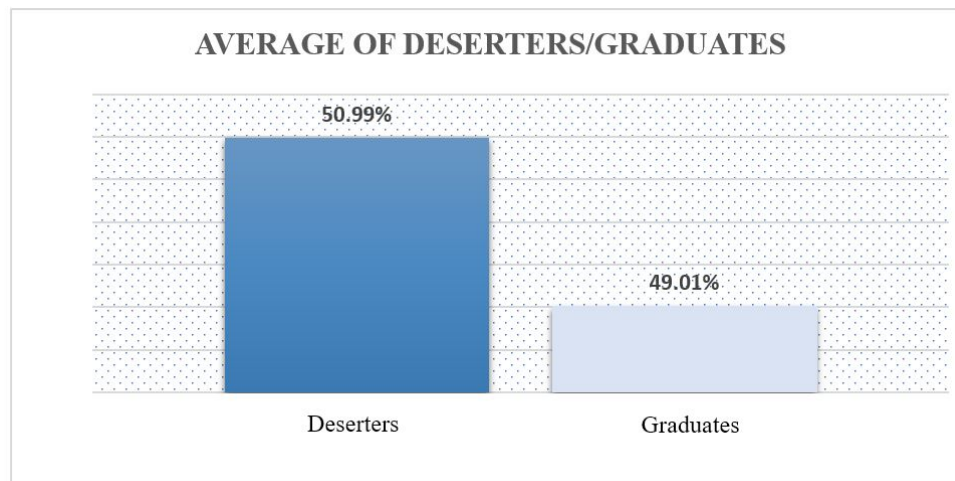


Figure 2. Overall average of dropouts/graduates

Based on the academic situation of students for each generational cohort and considering the percentage of graduates, dropouts and those without a degree, the percentage data is coded to be part of the input data for the PSPP statistical software and thus obtain the Mean, Standard Deviation and Range. The statistical results obtained are presented in the following Table 2.

Table 2. Statistics on graduates, dropouts and not graduated

	Media (μ)	Deviation Standard (σ)	Range		Range
			Maximum Value	Minimum Value	
Graduates	43.73	16.79	56.74	0.00	56.74
Dropout	48.87	23.84	89.00	0.00	89.00
Not graduated	89.51	17.92	100.00	40.91	59.09

In the following Figure 3 of dispersion type, the variation of each of the percentages of the parameters and their relationship with the metrics of the Mean, Standard Deviation and the Range is visualized, obtaining the following:

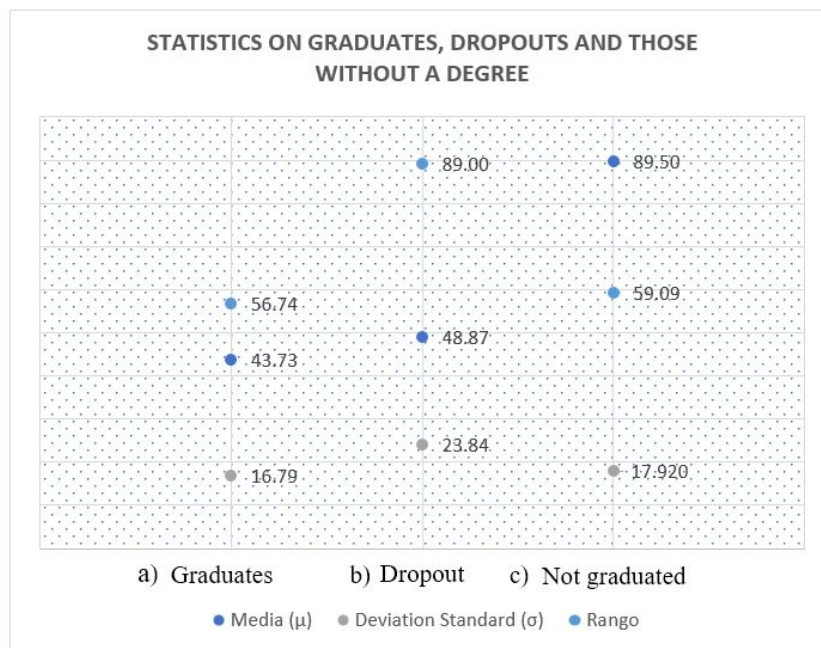


Figure 3. Statistics of the Parameters a) Graduates, b) Dropout y c) Not Graduated

Graduates Parameter. The value of the Mean 43.73% suggests that the students' terminal efficiency is relatively low. The value obtained in the Standard Deviation with 16.79% indicates a considerable variability between the cohorts, with some reaching up to a value of 56.74% and others only with a value of 0%, (Figure 3a). This could indicate significant differences in teaching methods or in student engagement.

Dropout Rate. As shown in Figure 3b, the obtained value of the Mean of 48.87% and the high Standard Deviation with a value of 23.84% indicate that there is a high level of dropout among students; the Range value of 89.00% suggests that some cohorts have extremely high dropout rates, which could be an area of concern and of primary interest for intervention to remedy the problem.

Percentage without Degree. In Figure 3c, the mean value of 89.50% indicates that a large proportion of students fail to graduate. Although the standard deviation of 17.92% is lower compared to other percentages, the range of 59.09% shows that there is still variability in the results.

Conclusion

The results obtained in the study lead us to suggest the need to review the educational strategies implemented in the Industrial Engineering degree. By analyzing the different cohorts over a certain period of time, it was easier to compare the terminal efficiency between different groups, helping to identify disparities and areas where additional attention is required. In this way, it was also possible to identify trends, thus allowing the institution to support this type of study, the possibility of evaluating the effectiveness of its teaching strategies. Highlighting as a primary characteristic, facing the unique challenges in each generation. This without leaving aside the adaptation to technological changes, since the generational cohorts also reflect how technology and teaching methodologies have evolved. It is imperative to understand how technological innovations affect learning and graduation. Or, alternatively, formulate more effective educational policies that address the specific needs of students and promote an inclusive academic environment. Understanding the characteristics of each cohort can help the institution foster a sense of community and belonging, which in turn can increase students'

motivation and commitment to their studies. It can also help reorient new approaches that lead to student retention until they complete and obtain their professional degree.

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