

Factors Associated with the Year of Admission and the Iq of Engineering Students at A Public University in Peru

Pedro Pablo Rosales López¹, Mercedes Puca Pacheco², César Augusto Tacuri Puca³, Mariela Elizabeth Andagua Moreno⁴, Christian Albert Aguirre Broncano⁵, Ender Ricardo Ramírez Fernández⁶, Bernard Edwin Yapo Esteban⁷

Abstract

This study investigates the evolution of intelligence quotient (IQ) among students in the Faculty of Industrial Engineering at the Universidad Nacional Mayor de San Marcos. The aim is to determine the influence of three factors on IQ: age, year of study, and month of university enrollment. Data was collected from a group of students using the Wechsler Adult Intelligence Scale (WAIS-IV), a standardized instrument for assessing general intelligence in individuals aged 16 to 90. An orthogonal experimental design was employed to compare mean IQ scores across different groups defined by age, year of study, and their combinations, using a three-way analysis of variance and interaction plots. Results confirm the influence of both age and year of study on IQ, as well as the existence of an interaction effect between both variables. These findings suggest that both natural cognitive development and exposure to academic training contribute to changes in IQ throughout the university trajectory. Additionally, an opportunity is identified for future research to delve deeper into the underlying mechanisms of these changes and explore strategies to optimize students' intellectual development.

Keywords: IQ, Factors Associated with Entry.

Introduction

Peruvian education is governed by the General Education Law 28044, which provides a comprehensive framework for the creation and dissemination of educational materials, teacher training, and educational research. [1] The integration of emerging technologies and innovative content is expected to significantly enhance the quality of education in the coming years. It is important to note that digital change is changing the relationship between educational institutions and their users. In addition, technology, such as artificial intelligence, will play an important role in this change.

Among the interests widely studied and evaluated by educational managers is the achievement of personal, academic, and professional success of students. Being able to know whether students have developed their physical, psychological, social, and intellectual skills is valuable information to be able to evaluate and implement strategic plans in cases of opportunities for improvement. Therefore, it is important to establish a way to measure the influence of the university in the development of these skills. This suggests that by assessing individual levels of intellectual ability, it becomes possible to implement targeted activities and programs designed to enhance these abilities. [2]

Intelligence tests are very popular in the development of intellectual ability. The calculation of the intelligence quotient (IQ) in university study centers has long been used to measure the intelligence of students and predict their academic success. However, relying entirely on IQ tests to assess students' intelligence may not be the most accurate or effective way to do so. According to a study by researchers at the University of Western Canada and the Science Museum in London, measuring human intelligence based

¹ Facultad de Ingeniería Industrial – Universidad Nacional Mayor de San Marcos.

² Facultad de Química e Ingeniería Química - Universidad Nacional Mayor de San Marcos

³ Facultad de Ingeniería Industrial - Universidad Nacional Mayor de San Marcos.

⁴ Facultad de Ingeniería Industrial - Universidad Nacional Mayor de San Marcos.

⁵ Facultad de Ingeniería Industrial - Universidad Nacional Mayor de San Marcos.

⁶ Facultad de Ingeniería Industrial - Universidad Nacional Mayor de San Marcos.

⁷ Facultad de Ingeniería Industrial - Universidad Nacional Mayor de San Marcos.

solely on an IQ test is "highly biased" and "fundamentally flawed." The study concludes that these tests fail to consider the complex nature of human intellect. Instead, the study recommends using cognitive tests that measure multiple aspects of intelligence, including memory, reasoning, attention, and planning ability. [3]

Among college students, on tasks that require intelligence, students with higher IQs tend to complete their tasks in fewer steps and in less time than students with lower IQs. It is also proven that students with higher memory capacity tend to remember things better and faster than other students with lower memory capacity [4].

This article aims to study the development of the IQ of students from the Faculty of Industrial Engineering (FII) of the Universidad Nacional Mayor de San Marcos (UNMSM), the oldest university in America. Thus, the final objective is to be able to statistically define the influence of the independent factors: age, year of study and the month of entering the university on the IQ of the students of the faculty.

What is Cognitive Intelligence?

Most people have the idea that cognitive intelligence can determine how intelligent someone is. However, such a premise cannot be affirmed. The debate on how to define a person's intelligence and what aspects should be considered in order to do so (problem solving, abstract thinking, creativity, memory, etc.) began more than a century ago and continues. Consequently, the most formal concept would be that of the American Psychological Association, which describes the abilities to understand complicated ideas, adapt to the environment that surrounds one, learning from experiences and participating in reasoning and decision making in any type of situation. [5]

To delve deeper into the topic we need to have some clear concepts such as that of cognitive intelligence. This intelligence "includes the ability to read, evaluate, prioritize and write using logic and reasoning. The brain's neocortex performs these functions independently of its emotional centers." [3]

The dictionary of the Spanish Academy of Language defines intelligence as "the ability to acquire and apply knowledge and skills." For David Wechsler, the developer of the Wechsler scales, intelligence is the ability of a person to act with a purpose, think rationally and live harmoniously with their environment. [6]

Ancient Chinese tradition defines intelligence as a general term for both intelligence and ability, and ancient Chinese thinkers generally considered wisdom and ability as two relatively independent concepts. [7]

Intelligence Quotient (IQ)

IQ interacts with other crucial skills, such as Emotional Intelligence, significantly influencing overall performance. For instance, a student with high IQ but average Emotional Intelligence may still excel in business, albeit with a different trajectory. [8] Socioeconomic factors, both individual (student's background) and institutional, can significantly impact this performance. Furthermore, IQ plays a crucial role in overcoming challenges. For example, in the face of digital inequality, students with higher IQ may be better equipped to adapt and mitigate the associated disadvantages. [9].

It is the number that allows measuring the intellectual capacity of a person. This value is obtained through standardized psychological tests. It is classified and varies according to the age of the person who will be tested. It is important to note that this number varies over time due to the growth of people, even taking into account the months. [10]

IQ tests are designed to measure mathematical skills, verbal communication, memory, and spatial awareness. Additionally, these skills are known to include problem-solving skills, comprehension, and spatial thinking. [6]

Table 1. Details Some of the Functions of the IQ, Separated by Aspect.

Aspect	Description
Evaluate	It can be used to analyze the academic performance or any other aspect of a person that is related to the IQ.
Classify	A group of people can be classified in intellectual terms, that is, if they are above or below average.
Select	It is used for selection processes of new personnel for companies or in general.
Diagnose	To diagnose illnesses or problems that are related to the person's learning.
Investigate	To carry out scientific studies and research.

IQ Test

In the Setiawan study, they recommend the use of a data collection instrument, based on the fact that the data collection tool used in that study was a questionnaire, and it is possible that respondents do not answer the questions accurately, so the analysis of the results may be biased. Using a data collection instrument reduces bias. [11]

The Wechsler Intelligence Scale is the most widely used intelligence test, with three tests designed for different age ranges: the WPPSI for preschool and primary school (2 to 7 years), the WISC for childhood and adolescence (6 to 16 years), and the WAIS for adulthood (16 to 90 years). The WAIS has been periodically updated, with the most recent versions being the WISC-V and the Digit Span Subtest of the Adult Intelligence Scale-Fourth Edition (WAIS-IV). [12] Wechsler divided intelligence into two main areas: verbal and performance, each subdivided and assessed with different subtests. The WAIS is an individual test that assesses overall intelligence, and has two scales: verbal and performance, based on Spearman's two-factor theory of intelligence.

There are other types of intelligence tests available, including a multiple intelligence test that measures different types of intelligence, including linguistic, logical-mathematical, visual-spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic intelligence. [12] The use of computerized batteries or computerized tests has increased in recent years to analyze cognitive function. [13]

An individual's IQ score is determined by comparing his or her performance on the test to that of others in his or her age group. An IQ score of 100 is considered average, while scores above or below this range indicate above- or below-average intelligence, respectively. So what is considered a high IQ score? In general, a score of 130 or above is considered high intellectual ability. However, it is important to note that IQ tests are not perfect measures of intelligence and should be interpreted with caution. A graph of IQ applied to the general population is shown in Figure 1. This graph shows the bell-shaped distribution of IQ values for a given population.

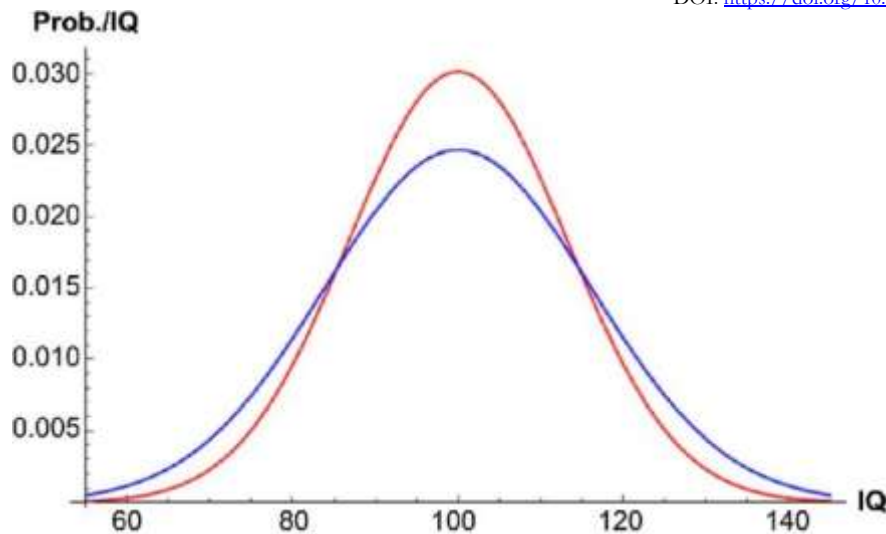


Figure 1. IQ Distribution Chart for the General Population

On the other hand, when it comes to defining a “normal” IQ score, we can refer to the range between 90 and 109, which is where most people fall. It is worth noting that IQ scores are distributed in a bell curve, with most people falling within the average range. But what about those people who score exceptionally high on IQ tests? These individuals are often referred to as “gifted” or “geniuses,” and typically have an IQ of 140 or higher. However, it is important to remember that IQ is only one aspect of intelligence. [14]

A summary of a person’s IQ classification is shown in Table 2.

Table 2. IQ Classification

Classification	Score range.
Very superior intelligence.	130 or more
Superior intelligence.	120-129
Brilliant normal intelligence.	110-119
Average normal intelligence.	90-109
Slow normal intelligence.	80-89
Borderline intelligence.	70-79
Mental deficiency.	Up to 69

Methodology

The present study aims to apply an experimental design to evaluate the statistical influence between the year of study, month of admission, age and IQ of students of the Faculty of Industrial Engineering (FII) of the Universidad Nacional Mayor de San Marcos (UNMSM). For this study, all students of the Faculty were summoned, those who agreed to participate, filled out and voluntarily completed the Google form provided. All students who agreed were briefly informed about the requirement of this study, agreeing to data privacy and signing an informed consent letter. This study was conducted in accordance with the rules of the Declaration of Helsinki used by the World Medical Association 2013. [15]

To this end, Table 3 shows the factors that have been taken into account in the present research.

Table 3. Independent Factors

Independent factors
Age
Month of admission
Year of studies

The values of the “Age” factor were grouped for the experiment as detailed in Table 4, which shows the levels of the Age factor.

Table 4. Grouping of Ages

Age Level	Ages included
1	17
	18
	19
2	20
	21
3	22
	23

The “month of admission” factor details the month in which they took the entrance exam to the school and passed. This admission process is generally offered in the months of September and March, and the start of classes for both cases occurs between the end of March and the beginning of April. In this way, although students from both months of admission may belong to the same study cycle, that is, they belong to different admission processes.

The values of the “year of study” factor consider the student’s current cycle and are classified into two levels, as shown in Table 5.

Table 5. Year of Study Grouping

Level of Studies	Cycles included
1	First cycle.
	Second cycle
	Third cycle.
	Fourth cycle.
	Fifth cycle.
	Sixth cycle.
2	Seventh cycle.
	Eighth cycle.
	Ninth cycle.
	Tenth cycle.

The information was collected through an anonymous survey prepared in the “Google Forms” tool, aimed at regular students of the Faculty of Industrial Engineering, that is; students with more than twelve credits enrolled, in the semester 2023-I. It was distributed among students from the first cycle to the ninth cycle.

This information was processed through a data analysis using the Google Collaboratory tool. So that it can be easily used over time.

Results

To obtain the results, we will follow the same steps as Avdeenko, to determine the interaction between the factors of the experiment and the study variable. [16]

The results of the three-way analysis of variance are shown in Table 6, in which the P value can be seen and those values that translate into a significance in the influence on the CI by being less than 0.05 are highlighted in bold.

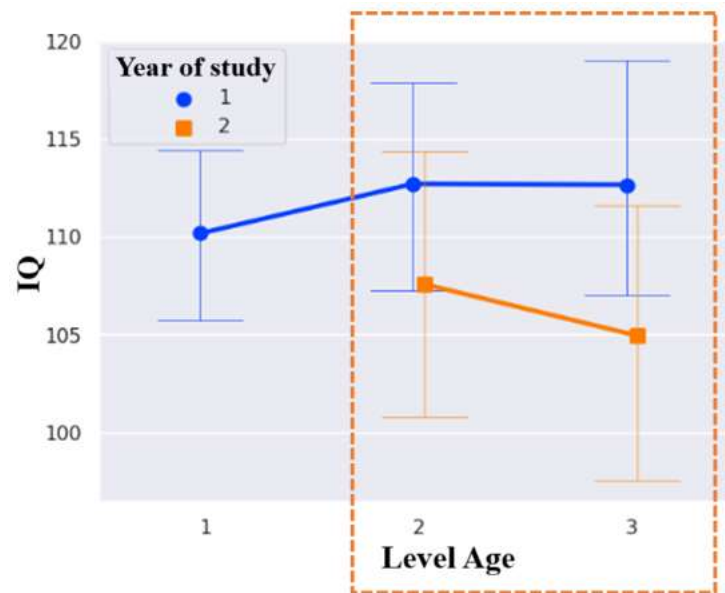
Table 6. Three-Way ANOVA Table

Source	SS	DF	MS	F	p-unc	np2
Age	345644.3	2	172822.2	976.2184	0	0.9663
Month of admission	0	1	0	0	1	0
Year of study	39245.35	1	39245.35	221.6848	0	0.7653
	102.1712	2	51.0856	0.2886	0.7502	0.0084
Age * Year of study	23822.36	2	11911.18	67.2826	0	0.6643
Month of admission * Year of study.	1.8245	1	1.8245	0.0103	0.9194	0.0002
Age * Month of entry * Year of study	575.3749	2	287.6875	1.6251	0.2045	0.0456
Residual	12038.19	68	177.0323			

We can see that the P value is below the value of $\alpha = 0.05$ for the interactions with age, year of study, and the interaction of age and year of study. This can be interpreted as meaning that statistically there is an influence of the age of the population for the average IQ to vary. That is, two populations with different average ages will probably have different IQ levels. The same logic is used for the interpretation of year of study and the interaction. Then, in order to determine whether this difference means any improvement in the IQ levels of the population, we will analyze the graph of the interaction detailed in the Age*Year of study row. [17] [18]

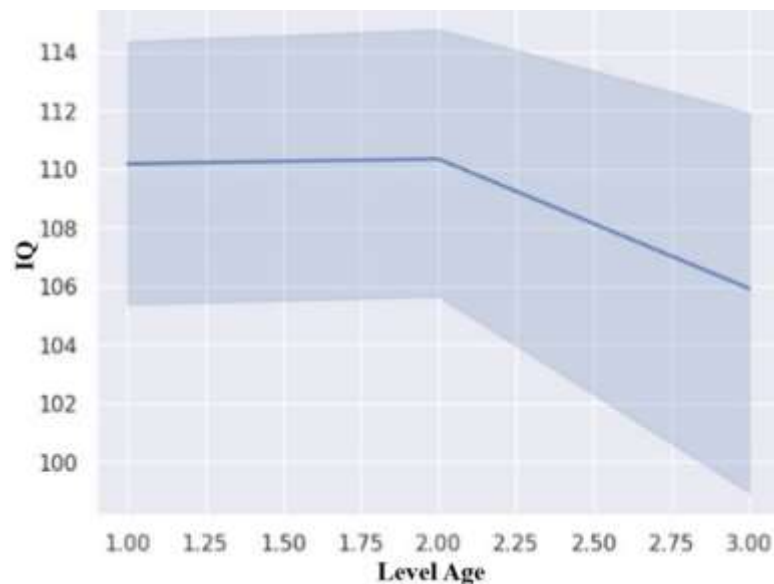
Figure 2 shows the interaction graph of the independent factors age and year of study on the IQ of the students.

Figure 2. Graph of the Interaction of Age*Year of Study



Since age group 1 includes those aged 17 to 19, they are not in the final years of their studies. Therefore, the comparison is made between age groups 2 and 3. Once the precision for interpreting the graph has been given, we can see that there is no significant statistical difference for lower cycle students in group 2 compared to group 3. However, something peculiar occurs for the upper cycles, since statistically, the older the student is and the more advanced he or she is, the slight decrease in the average IQ can be seen. In Figure 3, we can see that the IQ decreases as age increases.

Figure 3. Graph Of Student IQ By Age Group



Discussion of Results

The results are logical and consistent with previous studies. It turns out that age is a factor that influences the IQ of students. This was previously explained in the introduction of the article. Since even the months of the person's age at the time of measuring the IQ influence, it is statistically logical that the P value is very low and the η^2 value is very high with almost 0.93.

In Jahanian's work, he concludes that the academic performance of mechanical engineering students can be predicted by their IQ. This study goes in the same direction, since the performance of students is higher in the first semesters, which coincides with better IQ values. [15]

The year of study influences the IQ of students because throughout university learning it is expected that the students' abilities will develop, thus strengthening their knowledge and skills, which includes cognitive intelligence. This can be seen in the low P value and the high ETA of 0.76.

Another work with identical results is that of Nakisa, who concludes that sports performance is related to IQ. Intelligence is a main factor that determines victory in sports, especially in sports that require precise thinking, for a quick reaction, that precedes the action of the opponent. [19]

It is novel that when verifying the influence of age and year of study, it can be observed from the graph that there is a decrease in the IQ levels of students in higher cycles as their age increases. To do this, the distribution of IQ by age groups is carried out and it is observed that there is a decrease as the age range increases. [20]

Conclusions

From the three-way ANOVA table, it is concluded that:

- Age influences the IQ of students.
- The month of entry does not influence the IQ of students.
- The year of study does not influence the IQ of students.
- The interaction between age and month of entry does not influence the IQ of students.
- The interaction between age and year of study does not influence the IQ of students.
- The interaction between the month of entry and the year of study does not influence the IQ of students.
- The interaction of the three factors does not influence the IQ of students.

On the other hand, there is a decrease in the IQ of FII students of higher cycles as their age increases. This means an opportunity for improvement in the educational management of the faculty regarding the development of the intellectual skills of its students, specifically in cognitive intelligence, being one of the main capabilities of the profile of an engineer.

Within the framework of industrial digitalization, it is advisable to apply analysis carried out in Google Collaboratory periodically to establish variations in the results. This can be integrated into a database and obtain information and indicators quickly with updated information according to the needs of the institution.

References

- Guadalupe, C., León, J., Rodríguez, J. y Vargas, S. (2017). Estado de la educación en el Perú, Análisis y perspectivas de la educación básica. GRADE - FORGE, Primera Edición. Lima, Perú.
- Alegre Jara, M. E., Rojas Cordero, E. M., Calderon Reyes, E., Hernández Falla, J. V., Marcelo Gómez, G. F., Julca Castillo, B. L., & Castillo Ramos, N. E. (2024). Propuesta formativa para la intervención pedagógica de la superdotación y altas capacidades intelectuales. *European Public & Social Innovation Review*, 9, 1–20. <https://doi.org/10.31637/epsir-2024-999>

- Mishra, P. (2022). Quality of life (qol): role of IQ, eq and sq. *International Journal of Multidisciplinary Educational Research*, 18-24.
- Samar El-Keiey, Dina ElMenshawy, Ehab Hassanein. (2022). Student's Performance Prediction based on Personality Traits and Intelligence Quotient using Machine Learning. (IJACSA) *International Journal of Advanced Computer Science and Applications*, Vol. 13, No. 9, 2022
- Mukherjee A., Divya A.B., Sivvani M. y Pal S.K. (2024). Cognitive intelligence in industrial robots and manufacturing. *Computers and Industrial Engineering*, 191, art. no. 110106. DOI: 10.1016/j.cie.2024.110106
- Michelle de Souza. (2023). Testing Embryos for IQ. *LAW, TECHNOLOGY AND HUMANS*, Volume 5 (1) 2023,
- Yiqiang Feng, Leiju Qiu and Baowen Sun. (2020). A measurement framework of crowd intelligence. *International Journal of Crowd Science*, Vol. 5 No. 1, 2021 pp. 81-91, Emerald Publishing Limited 2398-7294 DOI 10.1108/IJCS-09-2020-0015
- Khan, S. (2019). A comparative analysis of emotionalintelligence and intelligence quotientamong Saudi business students' towardacademic performance. *International Journal of Engineering Business Management*, Volume 11: 1–10^a. DOI: 10.1177/1847979019880665
- JAM van Deursenand, A. y AGM van Dijk, J. (2023). IQ and digital inequality: An empirical investigation. *new media & society* 2023, Vol. 25(6) 1248–1270. DOI: 10.1177/14614448211024012
- Babarro, N. (2019). IQ: what it is, how it is measured, test and average value. *Online psychology*.
- Erwin Setiawan Panjaitan, Rahmat Budiarto. (2019). The Role of Intelligence in e-Learning Usage: An Extension of UTAUT Model. Volume 8, No.6, November – December 2019
- Susanty, E., Sijbrandij, M., Srisayekti, W., Suparman, Y. y Huizink, A. (2024). The effect of eye movement desensitization on neurocognitive functioning compared to retrieval-only in PTSD patients: a randomized controlled trial. *BMC Psychiatry*, Volume 24, Issue 1, December 2024 Article number 956. DOI: 10.1186/s12888-024-06420-9
- Kim, MS., Kim, K., Nam, J., Lee, SJ. y Lee, SW. (2024). Impact of Childhood Maltreatment on Cognitive Function and Its Relationship With Emotion Regulation in Young Adults. *J Korean Acad Child Adolesc Psychiatry* 2024;35:155-162. <https://doi.org/10.5765/jkacap.240001>
- Grabinski, M., & Klinkova, G. (2020). Scrutinizing Distributions Proves That IQ Is Inherited and Explains the Fat Tail. *Scientific Research Publishing*, 957-984. *International Journal of Advanced Trends in Computer Science and Engineering*
- Amir Jahanian Najafabadi, Hadis Imani, Reza Beygi, António Mendes Lopes, Lucas Filipe Martins da Silva. (2022). Intelligence, Beliefs on IQ and Learning Style predict Academic Performance in Mechanical Engineering Students. *U.Porto Journal of Engineering*, 8:1 (2022) 59-72. ISSN 2183-6493 DOI: 10.24840/2183-6493_008.001_0007
- Avdeenko, T.; Timofeeva, A.; Murtazina, M.; Razumnikova, O. (2021). Changes in the Intelligence Levels and Structure in Russia: An ANOVA Method Based on Discretization and Grouping of Factors. *Appl. Sci.* 2021, 11, 5864. <https://doi.org/10.3390/app11135864>
- Pingouin. (06/23/2023). Retrieved from Pingouin.anova: <https://pingouin-stats.org/build/html/generated/pingouin.anova.html#pingouin.anova>
- Pingouin. (06/23/2023). Retrieved from Functions: <https://pingouin-stats.org/build/html/api.html#anova-and-t-t est>
- Nima Nakisa, Mahboobeh Ghasemzadeh Rahbardar. (2021) Comparison of IQ, EI, Sports Performance, and Psychological Characteristics of Young Male Soccer Players in Different Playing Positions. *Ann Appl Sport Sci* 9(1): e910, 2021. <http://www.aassjournal.com>; e-ISSN: 2322-4479.
- Utomo, S., & Komarudin. (2022). Correlations Between Physical Fitness, Learning Motivation, Intellectual Quotient and Learning Habits Toward the Learning Outcomes of the Students of Sport Special Class in the High Schools Located in Special Region of Yogyakarta. *International Journal of Social Science Research and Review*, 43-52.