Determinants and Academic Performance: The Role of Prerequisites in University Achievement

Determinants and Academic Performance: The Role of Prerequisites in University Achievement

Maria Giulia Ballatore[*], Anita Tabacco[^]

Abstract
This study examines the relationship between incoming preparation and academic performance of engineering freshmen at Politecnico di Torino, within the context of transformative and sustainable processes in higher education. Based on a sample of 3,739 students, the research evaluates the predictive validity of the entrance exam (Test In Laib - TIL) and the national state exam (Esame di Stato – EdS), considering variables such as gender, geographical origin, and scholastic background. The results show a significant correlation between TIL scores and the university credits earned in the first year, highlighting the importance of the TIL in predicting academic success, while EdS scores are not correlated with performance. Students from scientific high schools and regions outside the North-West obtain higher TIL scores, indicating disparities in preparation. Gender differences also emerge: males achieve slightly higher TIL scores, while females score higher on the EdS. Binary logistic and quantile regression analyses confirm the effectiveness of the TIL as a predictive tool, suggesting the need to revise orientation and admission policies to better support students' transition from school to university. These results are crucial for refining educational strategies, better aligning students' preparation with academic and professional demands, contributing to reducing dropout rates and improving academic success.

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1. Introduction

The transition from high school to university represents a critical juncture in the academic trajectory of students, particularly in the field of Engineering. This transition often encompasses a range of challenges that can significantly impact students' academic performance, persistence in their chosen field of study, and their ability to navigate future career paths (Thompson et al., 2021). Among these challenges, the development of a solid study method characterized by autonomy and self-assessment, alongside a robust knowledge base in core subjects, is paramount (Arnold & Straten, 2012). Furthermore, students must navigate the social, financial, familial, and emotional adjustments associated with college life, complicating their academic journey and their ability to adapt to the evolving demands of both academia and the labor market (Bowles et al., 2013). Consequently, universities bear a social responsibility to guide potential candidates effectively, ensuring they make informed choices that align with their academic preparedness, career aspirations, and the broader socio-economic landscape, thus preventing prolonged and unproductive university careers.

In the context of today's global challenges, where educational and labour market demands are increasingly interconnected, effective preparation in higher education becomes crucial not only for academic success but also for fostering the development of strategic soft and life skills necessary for active and responsible citizenship.

Existing literature underscores the importance of effective preparation as a significant predictor of academic success across various countries and academic disciplines (Aquines Gutiérrez et al., 2022; Ferrão & Almeida, 2019; Nagy & Molontay, 2021). However, there is a noticeable gap in research concerning the Italian context, particularly regarding the relationship between incoming preparation and first-year performance in engineering students. This study aims to address this gap by examining the incoming preparation of freshmen in the engineering programs at Politecnico di Torino (Italy) and its correlation with their academic performance in the first year.

Politecnico di Torino is selected as the representative sample for this study due to its stature as one of the largest technical universities in Italy, providing a diverse and substantial student population for analysis. Preparation indicators

include the scores obtained in the university's entrance exam, the Test In Laib (TIL), and the evaluations from the national state exam, the Esame di Stato (EdS). In addition to these academic indicators, this study also considers gender, geographical background, and scholastic background as moderators, following evidence from existing literature that highlights their potential influence on academic outcomes.

The first-year academic performance of the students is measured by the number of university credits, Crediti Formativi Universitari (CFU), earned within the first year. Additionally, the achievement of a minimum threshold of 26 CFU, required to progress to the second year, is also evaluated as a key outcome measure.

By investigating these factors, this study aims to provide valuable insights into the determinants of academic success in engineering education within the Italian context. The findings are expected to inform educational policies and university support programs, ultimately contributing to better alignment between students' preparedness, academic demands, and career readiness. This alignment is crucial for enhancing student success rates, reducing dropout rates, and ensuring that students' educational experiences are both productive and fulfilling, thus equipping them to navigate and adapt to the changing demands of their professional and personal lives.

The structure of this paper is as follows: Section 2 provides a review of the literature on incoming preparation and the school-to-university transition. Section 3 details the methodology, specifying the sample, dependent and independent variables' distributions, and the statistical tools and methods of analysis employed. Section 4 presents the results, offering a comprehensive analysis of the data collected then used for the discussion in Section 5. Finally, Section 6 summarizes the key insights and suggests implications for policy, practice, and the development of strategic orientation processes that link school, university, and the labor market.

2. Incoming Preparation and the School-to-University Transition

The transition from high school to university is a critical moment for students, influenced by their incoming preparation and their ability to adapt to the new academic environment. The literature highlights that effective preparation can significantly predict the academic success of university students across different countries and types of careers. For instance, Aquines Gutiérrez et al. (2022) found that entry profiles and early study habits are closely related to first-year academic performance in engineering programs, emphasizing the importance of structured preparatory activities and self-

regulated learning strategies in Mexico. Similarly, Ferrão and Almeida (2019) demonstrated that university entrance scores are a differential predictor of first-year academic performance in Portugal, suggesting that these scores capture essential skills and knowledge critical for success in higher education. Nagy and Molontay (2021) provided a comprehensive analysis of the predictive validity of university entrance scores in Hungary, confirming that these scores are strong indicators of students' future academic performance and can serve as reliable tools for university admissions processes. These studies collectively underscore the universal relevance of thorough preparatory mechanisms and entrance assessments in forecasting academic outcomes, underscoring the necessity to examine such factors within the Italian context to enhance educational alignment and student support strategies.

In the Italian context, the transition to university involves numerous factors, including difficulties in adapting to study methods and acquiring knowledge of core subjects (Nigris, 2014). Moving to university is a complex process that encompasses personal, institutional, and pedagogical dimensions. It represents a significant change in the freshman's trajectory, requiring them to redefine their life project and develop new strategies (Biasin, 2021). This transition is influenced by various psychosocial factors, which can impact academic performance and the development of generic skills (González, 2011). Therefore, the transition to university is not only a key life choice but a multifaceted process that requires support and attention from both the school and the university (Petruccelli et al., 2008). The assessment of incoming preparation through standardized tests has been studied for their predictiveness on academic success, including the field of Engineering (Petrucci, 2017).

Specific studies have examined how admission criteria and pre-entry characteristics can predict academic performance in the first year (Munđar et al., 2015; Van Zyl et al., 2012). Lowe et al. (2018) highlighted the importance of the type of previous study in relation to engineering students' performance. Their findings indicated that students with strong secondary school performance tend to achieve higher in their engineering degree programs when they have a more diverse range of secondary school subject choices. This implies that high-performing students gain from broader academic challenges, while lower-performing students benefit more from maintaining a narrower focus in their secondary school studies. In the Italian context, Nuzzaci (2015) investigated how the entrance test for the Primary Education Sciences degree course influences success in educational design, suggesting that pre-university preparation is crucial for facing initial academic challenges.

3. Aim and methodological approach

This study adopts a rigorous methodological approach to examine the level of incoming preparation of freshmen in the area of Engineering at the Politecnico di Torino for the academic year 2021/22. The study sample consists of 3,739 freshmen out of a total of approximately 5,000 (75%), selected by excluding those who did not meet the defined inclusion criteria, such as admission date and completion of the EdS. Additionally, following the evidence in literature, gender, geographical, and scholastic background are considered as moderators. This research adheres to ethical standards, ensuring that all procedures are compliant with the relevant ethical guidelines and regulations.

3.1 Sample

The freshmen were divided based on gender and geographic origin (Table1).

Table 1 - Geographic origin of freshmen students by gender

Region	Females	Males	Total
North-West	539	1,749	2,288
North-East	20	70	90
Center	66	140	206
South and Islands	312	843	435
Total	937	2,082	3,019

Furthermore, the students' previous educational background before university was examined, with particular attention to the types of high schools completed (Table 2).

Table 2 - High School background of freshmen students by gender

Type of high school	Females	Males	Total
Classical	81	80	161
Linguistic	81	59	140
Scientific	692	1,879	2,571
Technical	58	741	799
Other	25	43	68

Regarding the inclusion criteria for the sample, all freshmen were considered, except those enrolled in Industrial Production Engineering and the professionalizing degree program in Techniques for the Manufacturing

Industry, which do not follow the common first year for all other degree courses in the area of Engineering. Only active freshmen as of November 1, 2021, with an Italian EdS (students with other state exams were excluded) and not transferred from other universities were included in the sample.

The study covers the academic year 2021/22, considering the acquisition of CFUs at the end of the September exam session. The three exam periods of the academic year under observation were included: January/February, June/July, and September.

3.2 Independent and Dependent factors

Admission is managed through the TIL, which, due to the pandemic, was made available remotely. The first year of studies is common to all 5,000 freshmen, regardless of the chosen degree course, with 21 parallel courses organized alphabetically for each core subject. The first semester includes Mathematical Analysis I (10 CFU), Chemistry (8 CFU), Computer Science (8 CFU); the second semester includes Linear Algebra and Geometry (10 CFU), Physics I (10 CFU). The only difference in the study plan concerns a core course, which varies according to the chosen degree course and can be worth 6, 8, or 10 CFU. Therefore, the maximum number of CFUs at the end of the first year is 52, 54, or 56 CFUs.

Thanks to extensive experience and a large statistical database, the TIL ensures transparency, robustness, and effectiveness (Ballatore et al., 2018). At the time of registration for the TIL, candidates are asked to indicate up to five degree programs in order of preference. The test is conducted on the Moodle platform using proprietary hardware and software, with multiple test dates available starting from February each year, allowing each candidate to retake the test up to three times a year.

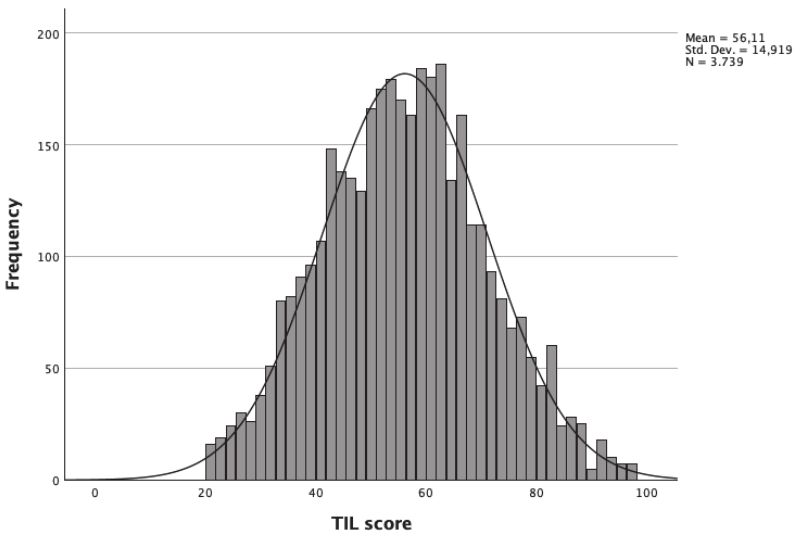
The TIL consists of 42 multiple-choice questions of varying difficulty divided into four sections: mathematics, physics, verbal comprehension, and logic. The total time available is 90 minutes. The mathematics section contains 18 questions (40 minutes), the physics section 12 questions (26 minutes), and the verbal comprehension and logic sections 12 questions (12+12 minutes). Each quiz offers five possible answers, only one of which is correct. The score is calculated by awarding one point for each correct answer and subtracting 0.25 points for each incorrect answer. Missing answers do not affect the score. The test result, reported on a 100-point scale, is calculated automatically and can be viewed at the end of the test or at any time on the candidate's personal web page. To support TIL preparation, comments and training tools (video recordings, exercises, and simulations) are available.

The best result out of the possible three attempts, expressed on a 100-point scale, is used to form the ranking where candidates are listed with a minimum score of 20/100, while a threshold of 60/100 guarantees admission to the degree program indicated as the first preference.

The distribution of TIL scores (Figure 1) shows a tendency towards a normal distribution centred around a mean score of 56.11/100 with a standard deviation of 14.9.

The EdS is structured into several parts aimed at evaluating the skills acquired by students during their high school education, expressed with a numerical score out of 100 with a minimum for obtaining the diploma of 60/100. The exam normally consists of two written exams (max 40/100) and an oral interview (max 20/100), to which the performance of the last three years is added for a maximum of 40/100. The first written part is an essay in Italian and assesses linguistic and textual analysis skills

Figure 1 - Distribution by TIL score



The second written part is thematic, specific to the chosen field of study. For example, students in Scientific high schools can have either Mathematics of Physics. Finally, the oral interview aims to evaluate the student's expressive and critical abilities, including the analysis of texts, and the discussion of interdisciplinary topics with a commission of internal and external teachers. In 2020/21, due to the COVID-19 pandemic, the structure of the EdS was modified to adapt to exceptional circumstances. The exam was conducted

without the traditional written parts and focused on a single oral interview (max 40/100), combined with the previous academic performance (max 60/100).

In our sample, analyzing the intermediate ranges, there is some dispersion with a slight predominance of above-average scores:

- Scores between 60 and 69/100: 168 students (around 4.0% of the total)
- Scores between 70 and 79/100: 419 students (around 11% of the total)
- Scores between 80 and 89/100: 714 students (around 19% of the total)
- Scores between 90 and 99/100: 983 students (around 26% of the total)
- Score of 100/100: 1,455 students (around 39% of the total).

Besides the predominance of the maximum score, there is a significant concentration around round numbers. For example, 4.1% of students obtained 80/100, while 4.4% obtained 90/100. The concentration of higher scores and the high frequency of the maximum score indicate a strong presence of excellent students in the sample. This could be attributed to the fact that the engineering field attracts a population with high academic performance, confirming the hypothesis of the self-selective effect. Additionally, the distribution of scores around round numbers might suggest a tendency in the system to favor these perceived threshold scores. For the purposes of the study, the sample was analyzed both as a whole and considering two subsets:

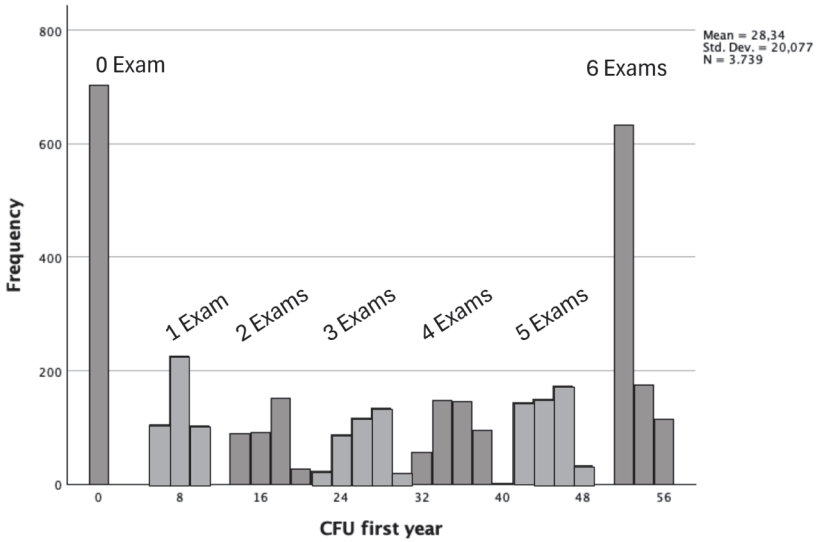
- Scores between 60 and 94/100 (1,779 – 48%)
- Scores greater than or equal to 95/100 (1,960 – 52%).

The analysis of CFUs obtained during the first academic year provides further information on the performance of the freshmen considered. Descriptive statistics indicate an average of 28.34 CFUs acquired, with a standard deviation of 20. About 43% do not reach the minimum threshold of 26 CFUs, and among these, a high percentage does not pass any exams (18.8%). This data aligned with the literature suggesting that a significant number of individuals encounter difficulties in the university transition. Nevertheless, more than half of the sample manages to surpass the threshold, and 24.6% acquire all the credits by passing the six exams of the first year.

The distribution of CFUs is skewed, with a significant concentration of the sample acquiring few CFUs and a long tail of freshmen with a high number of CFUs (Figure 2). Considering the number of exams passed:

- 18.8% no exams
- 11.6% one exam (6-8-10 CFU)
- 9.6% two exams (12-14-16-18-20 CFU)
- 10.2% three exams (22-24-26-28-30 CFU)
- 11.9% four exams (32-34-36-38-40 CFU)
- 13.3% five exams (42-44-46-48-50 CFU)
- 24.6% six exams (52-54-56 CFU).

Figure 2 - Distribution by CFUs earned with an indication of the number of exams passed



3.3. Statistical Tools and Methods of Analysis

The software used for the analyses is SPSS 29. To analyze the correlations between the different factors, transformed into standard deviations, Spearman's rank correlation coefficient is employed, chosen for its ability to handle monotonic relationships and the non-parametric nature of the collected data. Since the TIL score has homogeneous variance (Levene' Test is not significant for either the type of school $p = 0.378$ or the geographical origin $p = 0.122$), a one-way ANOVA with Tukey's HSD Test is used to determine which schools differ statistically from each other. Conversely, the EdS score does not have homogeneous variance with respect to geographical ($p < 0.001$) and school ($p < 0.001$) characteristics, thus necessitating the use of Welch's ANOVA.

To further explore significant differences among groups, post-hoc tests such as Games-Howell is used following Welch's ANOVA. Additionally, to assess differences in TIL scores among different types of high schools and geographical areas, standard ANOVA and Tukey's HSD tests is employed.

For binary outcomes, such as the probability of exceeding the threshold of 26 CFUs, a binomial logistic regression is conducted. This method allows for the analysis of binary outcomes (i.e., whether the student exceeds the CFU threshold or not) and the identification of significant predictors among the independent variables. The model's goodness of fit was evaluated using

Nagelkerke R-squared, and the classification accuracy was assessed to understand the model's predictive power.

To examine the impact of various predictors across different quantiles of the dependent variable, quantile regression was applied. This approach offers insights into the influence of significant variables at different points in the distribution of CFUs, beyond the mean effects typically analyzed in ordinary least squares regression.

These methodological approaches are chosen to ensure an in-depth and robust analysis of the variables of interest. They provide a clear understanding of the dynamics that influence the academic performance of students in their first year of engineering studies, as explained in the introductory section.

4. Results

It should be noted that all dependent and independent factors were normalized for correlation analysis. Considering the overall sample (Table 3), there is a significant medium correlation between CFUs acquired and the TIL score ($r = .451$, $p < .01$), while there is no significant correlation between CFUs acquired and the EdS score. When considering the individual sections, there is a low to medium correlation with each of them and the CFUs acquired. Additionally, the correlation between the TIL score and the EdS evaluation is low but significant ($r = .137$, $p < .01$).

Regarding the TIL sections, each of them shows a medium to high significant correlation (**$p < .01$):

- TIL / Mathematics: $r = .802$**
- TIL / Physics: $r = .723$**
- TIL / Logic: $r = .410$**
- TIL / Verbal Comprehension: $r = .353$**

Table 3 - Spearman's Correlation with Factors in SD

			CFU First Year	EdS	TIL	Mathematics	Physics	Logic	Verbal Comprehension
Spearman's Rho	CFU First Year	Correlations coefficient	1	0,03	,451**	,393**	,392**	,144**	,145**
		Sig. (2-tailed)	.	0,064	<,001	<,001	<,001	<,001	<,001

**. Correlation is significant at the 0.01 level (2-tailed).

Subsequently, considering the distribution of EdS scores, the sample was divided into two subsets with respect to the score of 95/100. For the population

with a score below 95/100 (n=1776), only the TIL score showed a medium statistically significant correlation with the CFUs acquired (Table 4). The correlation between the TIL score and CFUs acquired increases while remaining significant for freshmen with scores equal to or above 95/100 (n = 1960). Regarding the EdS evaluation, it is statistically null (Table 5).

Table 4 – Spearman's Correlation for Freshmen with EdS <95/100

			CFU First Year	EdS	TIL
Spearman's Rho	CFU First Year	Correlations coefficient	1	0,005	,379**
		Sig. (2-tailed)	.	0,846	<,001

Table 5 – Spearman's Correlation for Freshmen with EdS ≥95/100

			CFU First Year	EdS	TIL
Spearman's Rho	CFU First Year	Correlations coefficient	1	-0,074**	,493**
		Sig. (2-tailed)	.	,001	<,001

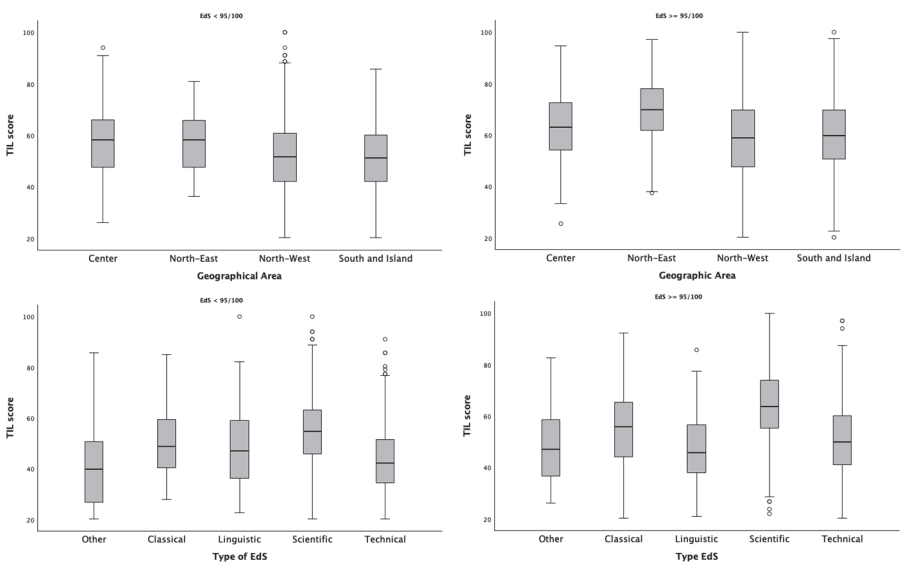
An analysis of variance (ANOVA) was conducted to assess the differences in TIL scores among the different types of schools: Classical, Linguistic, Scientific, Technical, and Other. The results revealed a statistically significant difference in mean TIL scores among the groups ($F(4, 3734) = 137.4$, $p < 0.001$). To specifically identify which groups differed from each other, a Tukey's HSD test for multiple comparisons is performed. The results of the Tukey's HSD test shows that freshmen from the Scientific high school scored significantly higher than those from the Classical high school (diff = 6.0, $p < 0.001$), Linguistic high school (diff = 11.2, $p < 0.001$), Technical institute (diff = 11.9, $p < 0.001$), and Other (diff = 15.4, $p < 0.001$). Additionally, those from Classical studies score significantly higher than those from the Linguistic high school (diff = 5.1, $p = 0.013$), Technical institute (diff = 5.9, $p < 0.001$), and Other (diff = 9.3, $p < 0.001$).

To evaluate the differences in TIL scores among different geographical areas (North-West, North-East, Center, and South and Islands), an analysis of variance is again conducted. The results reveal statistically significant differences in mean TIL scores among the groups ($F(3, 3735) = 26.8$, $p < 0.001$). Tukey's HSD test for multiple comparisons shows that students from the North-East scored significantly higher than those from the North-West (diff = 9.8, $p < 0.001$), while students from the Center score significantly higher than those from the North-West (diff = 6.5, $p < 0.001$) and the South and Islands

(diff = 4.1, p = 0.002). Additionally, students from the South and Islands score significantly higher than those from the North-West (diff = 2.4, p < 0.001). The homogeneous subsets identified by Tukey's HSD test indicate that the North-West and South and Islands areas belong to a group with lower average scores, while the Center and North-East areas form a group with higher average scores.

Considering the EdS evaluation with respect to geographical and school characteristics (Figure 3), Levene's test indicates that the variances among the groups are not homogeneous, and consequently, Welch's ANOVA, which is robust to unequal variances, is used. Welch's ANOVA reveals significant differences in EdS scores among schools ($F(4, 288.9) = 5.8$, $p < .001$) and geographical areas ($F(3, 323.447) = 111.5$, $p < .001$). The standard ANOVA results confirms these differences (respectively $F(4, 3734) = 7.0$, $p < .001$ and $F(3, 3735) = 94.1$, $p < .001$). To further explore these differences, Games-Howell post-hoc tests are performed. The results show that freshmen from other schools scored significantly lower than those from the Classical high school (diff = −7.7, p = .002) and the Technical institute (diff = −5.6, p = .032). Additionally, those from Classical studies score significantly higher than those from the Scientific high school (diff = 2.7, p = .002) and the Technical institute (diff = 2.1, p = .048). Furthermore, students from the North-East score significantly lower than students from other areas. Students from the North-West score significantly higher than students from the Center (diff = 4.3, p < .001) and the South and Islands (diff = 6.1, p < .001).

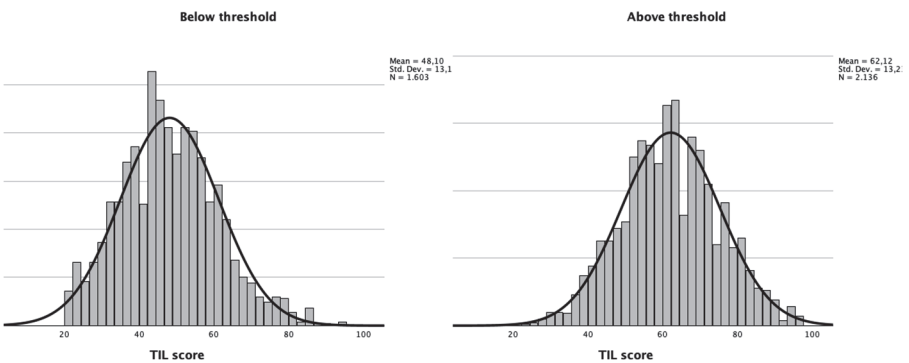
Figure 3 - Distribution of TIL and EdS by Type of EdS and Geographical Area



The results indicate a significant difference between the TIL scores of males (mean = 56.65) and females (mean = 54.51), with an average difference of 2.14 points ($t(3737) = 3.805$, $p < 0.001$). The effect size analysis, measured with Cohen's d (0.144), suggests that the effect size is small. The Mann-Whitney test was used to compare EdS scores between males and females. The results indicate that there is a significant difference between the two groups ($Z = -9.506$, $p < 0.001$). These results suggest that females tend to obtain significantly higher EdS scores than males.

The trend of TIL scores is subsequently checked with respect to exceeding the threshold, observing that the distribution remains normal in the two subsets, shifting to the right by 14/100, which is equivalent to a difference of 5/6 correct questions out of 42 (Figure 4).

Figure 4 - Distribution of TIL Scores for those below threshold (a) and above threshold (b)



A binary regression analysis is then conducted to investigate the factors influencing the exceeding of the 26 CFU threshold in the first year of the engineering course. The goal is to understand which variables, including standardized TIL and EdS scores, type of attended school, geographical area of origin, and gender, have a significant impact on exceeding this critical threshold. The binary regression model is statistically significant with a Nagelkerke R-squared of 0.324, indicating that the variables considered explain a significant portion of the variation in the dependent variable. The model is able to correctly classify a significant percentage of cases. For example, considering a threshold value of 0.5 for the predicted probability of CFU exceeding, the model correctly classifies 72.2% of the overall cases. The model coefficients (Table 6) indicate that standardized TIL and EdS scores are significantly associated with exceeding the threshold. Additionally, the type of attended school and the geographical area of origin also have a significant

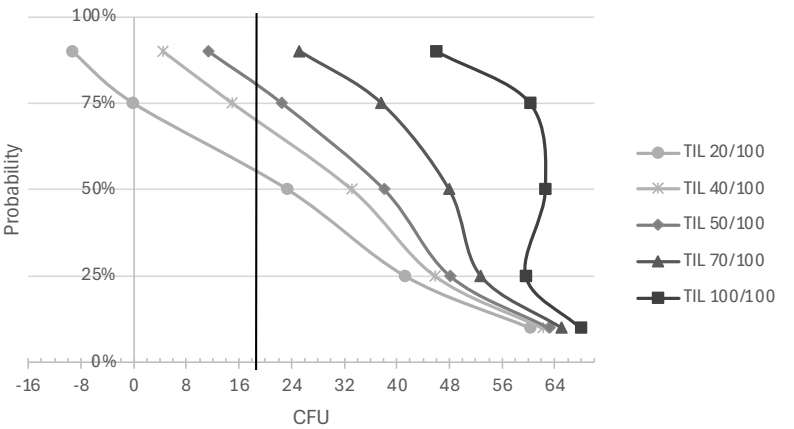
impact: freshmen from the Scientific high school and the North-West show a higher probability of exceeding the threshold compared to those from Technical institutes and South and Islands.

Table 6 - Variables in the Binomial Logistic Regression Equation with respect to the Threshold

Variables in the Equation

		B	S.E.	Wald	gl	Sign.	Exp(B)
Fase 1[a]	TIL [SD]	1,099	,049	494,092	1	<,001	3,002
	EdS [SD]	,313	,039	66,203	1	<,001	1,368
	Technical Institute			28,777	4	<,001	
	Other	-,302	,317	,908	1	,341	,739
	Classical high school	,093	,202	,210	1	,647	1,097
	Linguistic high school	-,371	,223	2,770	1	,096	,690
	Scientific high school	,381	,100	14,430	1	<,001	1,463
	South and Island			15,217	3	,002	
	Center	,065	,186	,123	1	,726	1,067
	North-East	,034	,276	,015	1	,901	1,035
	North-West	-,301	,086	12,327	1	<,001	,740
	Female	,095	,093	1,052	1	,305	1,100
	Constant	,290	,109	7,096	1	,008	1,336

Figure 5 - Typology of the Probability of CFU Exceedance for a Freshman from Scientific High School with EdS 100/100



Finally, the entire sample was used to estimate parameters through quantile regression to explore how significant variables influence the probability of exceeding the 26 CFU threshold. The result of the parameter estimates for various quantiles ($q = 0.1$, $q = 0.25$, $q = 0.5$, $q = 0.75$, $q = 0.9$) shows how these variables influence the probability of success in the first year of engineering for a student coming from the Scientific high school with a perfect score (100/100) in the EdS (Figure 5).

5. Discussion

The significant differences in the average TIL and EdS scores among the different geographical areas suggest that students from outside the North-West might be more self-selected, as they face considerable relocation and subsequent logistical and financial challenges. This finding highlights the potential influence of regional disparities on student preparation and university performance.

The observed variability in TIL and EdS scores among different types of schools shows differences in curricula, quality of teaching, and other educational and socio-economic factors that impact school performance. Notably, freshmen from Scientific high schools achieve significantly higher TIL scores compared to students from other schools, indicating that the curricula of scientific high schools may better prepare students for engineering studies. This aligns with the findings of Petrucci (2017), who reported that other standardized entrance tests for Engineering study used in Italy have similar predictive validity for university success.

The analysis also reveals a significant difference in TIL scores between males and females, with males scoring slightly higher. However, the effect size is minimal, suggesting that this difference may not be practically significant. On the other hand, females tend to have higher average scores in the EdS, with this difference being statistically significant. This gender disparity in performance warrants further investigation to understand the underlying causes, as supported by Núñez-Peña et al. (2024), who highlighted structural differences in gender depending on the type of examination (in our case multiple choice of TIL vs a comprehensive evaluation of EdS) that could explain the observed ambiguities in our analysis.

A crucial finding from the analysis is that the EdS score is not correlated with first-year academic performance in Engineering, whereas the TIL score is a more stringent and reliable indicator, capable of discriminating even among freshmen with high EdS scores. This suggests that the TIL is a more accurate

tool in assessing the skills necessary to succeed in the first year of Engineering programs.

The binary and quantile regressions provide additional insights. The binary regression demonstrates that students with higher TIL scores have a significantly higher probability of success in the first year, regardless of their EdS score. This reinforces the fact that the TIL is a more effective predictor of university performance. Furthermore, quantile regression analysis shows that students from scientific high schools with 100/100 EdS scores have a 90% probability of gaining at least 26 CFUs if they score more than 70/100 on the TIL. This finding underscores the TIL's effectiveness in identifying students with high academic potential.

However, this study has some limitations. While the sample is large and representative, the study is based on data collected from a single institution (Politecnico di Torino). Additionally, qualitative factors such as students' personal motivation, family support, and extracurricular experiences, which could significantly impact academic performance, are not included in the analysis. These factors should be explored in future studies to provide a more comprehensive understanding of the determinants of academic success.

6. Conclusions

This study provides an in-depth understanding of the correlations between demographic, educational, and academic performance variables of engineering freshmen at the Politecnico di Torino. The findings indicate that factors such as geographical origin and type of high school significantly influence performance in both entrance exams (TIL) and state exams (EdS). The results underscore that the TIL is a more predictive tool for academic success than the EdS, suggesting that admission criteria may benefit from placing greater emphasis on skills assessed by the TIL.

Furthermore, these results highlight the importance of considering not only students' prior academic performance but also their socio-geographical context and previous educational background when predicting success in the first year of engineering studies. These insights have several practical implications in academic guidance and student support. High schools could leverage these findings to better guide students toward academic paths that maximize their potential for success in university courses, particularly in engineering. Scientific high schools, for instance, may be recognized as a good preparatory path for students interested in pursuing engineering studies, given their positive correlation with higher TIL scores. In addition, identifying geographical areas and school types where students may face greater challenges could help

institutions provide targeted support to groups that may be at risk of struggling during their first years of study. Tailored support programs addressing the specific needs of these students could enhance retention rates and academic success.

As shown by Molontay and Nagy (2022), these results can inform a revision of the TIL to increase its predictive validity. In addition, this study opens avenues for future research that adopts a longitudinal approach, evaluating the predictive validity of TIL across the entire bachelor's program. Such an approach would enable a more comprehensive analysis of the long-term impact of input factors on academic success throughout the course of study.

In conclusion, these findings can guide educational policymakers and university administrators in developing strategies to enhance student success. By refining selection processes and providing targeted support, Engineering schools can better align students' preparedness with academic demands, ultimately improving retention rates and fostering higher academic performance.

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