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Rethinking Resource Allocation in Mexican Secondary Education: Efficiency Evidence from Three School Modalities

Repensando la asignación de recursos en la educación secundaria mexicana: Evidencia de eficiencia de tres modalidades escolares

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Abstract

This study examines the efficiency of lower secondary education policy delivery in Mexico at the municipal level from 2010 to 2017, employing Data Envelopment Analysis (DEA) to evaluate three service modalities—general schools, technical schools, and telesecundarias—against standardized learning outcomes in Spanish and Mathematics. Using budget, schools, enrollment, teachers, and administrative staff as inputs, and the number of students achieving proficiency levels III (good) and IV (excellent) on the ENLACE and PLANEA assessments as outputs, the analysis reveals persistently low efficiency scores across all modalities: a global technical efficiency average of 0.175, a pure technical efficiency of 0.270, and a scale efficiency of 0.630. Technical schools outperformed general schools and telesecundarias, yet no modality approached the efficiency frontier. Slack analysis confirms systematic resource overuse relative to learning outcomes. These findings challenge the prevailing input-expansion logic of Mexican education policy and argue for targeted reallocation strategies, modality-specific interventions, and outcome-oriented governance to bridge the gap between resource deployment and student achievement.

Keywords: Data Envelopment Analysis, educational efficiency, secondary education policy, Mexico, ENLACE, PLANEA, resource allocation, public education governance

Clasificación JEL: H52, I21, I28, C14, O15

Resumen

Este estudio examina la eficiencia de la política educativa en la educación secundaria en México a nivel municipal de 2010 a 2017, empleando el Análisis de la Envolvente de Datos (DEA) para evaluar tres modalidades de servicio—secundarias generales, técnicas y telesecundarias—en relación con los resultados de aprendizaje estandarizados en español y matemáticas. Utilizando como inputs presupuesto, escuelas, matrícula, docentes

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y personal administrativo, y como outputs el número de estudiantes en los niveles III (bueno) y IV (excelente) de las evaluaciones ENLACE y PLANEA, el análisis revela puntajes de eficiencia persistentemente bajos en todas las modalidades: una eficiencia técnica global promedio de 0.175, una eficiencia técnica pura de 0.270 y una eficiencia de escala de 0.630. Las secundarias técnicas superaron a las generales y telesecundarias, aunque ninguna modalidad se aproximó a la frontera de eficiencia. El análisis de holguras confirma un uso sistemáticamente excesivo de recursos respecto a los resultados de aprendizaje. Estos hallazgos cuestionan la lógica de expansión de insumos predominante en la política educativa mexicana y argumentan a favor de estrategias de reasignación focalizadas, intervenciones específicas por modalidad y una gobernanza orientada a resultados para cerrar la brecha entre la inversión de recursos y el logro educativo.

Palabras clave: Análisis de la Envolvente de Datos, eficiencia educativa, política educativa secundaria, México, ENLACE, PLANEA, asignación de recursos, gobernanza educativa

Clasificación JEL: H52, I21, I28, C14, O15

1. Introduction

Mexican secondary education stands at a critical juncture. Despite decades of policy reform, increased public spending, and institutional restructuring, student performance at the lower secondary level remains persistently weak by international standards. Mexico consistently ranks among the lowest-performing OECD countries in reading comprehension, mathematics, and science on the Programme for International Student Assessment (PISA), and the 2018 results confirmed that little progress had been achieved since the early 2000s (OECD, 2019). This structural underperformance raises fundamental questions about whether Mexico's education policy paradigm—which has traditionally prioritized input expansion over outcome optimization—is capable of delivering meaningful improvements in learning.

The concept of educational quality is inherently multidimensional, shaped by processes operating at the systemic, institutional, classroom, and household levels (Morales, Zúñiga, & García, 2016). As Carvallo (2006) noted, three analytical perspectives dominate the field: school effects, effective schools, and school improvement. Yet a persistent tension exists between those factors amenable to policy intervention—teacher allocation, infrastructure investment, curricular design—and those that lie beyond the direct reach of education governance, such as socioeconomic background and family capital (Coleman, 1988; Carvallo, 2006). This distinction is crucial for policy design: understanding where public resources can make a difference, and where they cannot, is the foundation of evidence-based educational governance.

From a theoretical standpoint, the educational technology tradition emphasizes rational curriculum design and process control to ensure system-wide efficiency (Postman & Weingartner, 1969). This perspective intersects with Adams and Aarto's (1975) insight that students learn effectively only when knowledge connects meaningfully to their lived experience. The implication for policy is clear: efficient resource deployment alone is insufficient; resources must be channeled through pedagogically sound structures that engage students meaningfully. The OECD (2018) has urged member states to strengthen standards, develop local monitoring capacity, and align evaluation frameworks with improvement-oriented policy cycles—a recommendation that Mexico has only partially heeded.

In Mexico, the evaluation landscape has been shaped by two successive standardized assessment programs: the National Assessment of Academic Achievement in Schools (ENLACE, 2006–2013) and the National Plan for the Evaluation of Learning (PLANEA, 2015–present). ENLACE was criticized for its high-stakes accountability logic, which incentivized teaching to the test and manipulation of results (Jiménez, 2016). PLANEA attempted to shift the evaluation culture toward diagnostic and formative purposes, yet its implementation has been uneven and its results equally discouraging (Saulés & Guzmán, 2019). The 2019 constitutional reform that dissolved the National Institute for Educational Evaluation (INEE) and created the new autonomous evaluation body further complicated the institutional architecture of assessment-based governance (Moran, 2019).

Against this backdrop, the present study uses Data Envelopment Analysis (DEA) to measure the technical efficiency of Mexican lower secondary education at the municipal level across its three service modalities—general schools, technical schools, and telesecundarias—from 2010 to 2017. The central hypothesis is that efficiency has been systematically low across all modalities due to the misallocation of educational inputs relative to measurable learning outcomes. Rather than simply documenting inefficiency, this study situates its findings within the broader policy debate about whether Mexico's education governance model requires fundamental restructuring toward outcome-oriented accountability and modality-specific resource strategies.

This article is structured as follows. Section 2 reviews the empirical literature on educational quality and efficiency. Section 3 presents the methodology. Section 4 develops the DEA model. Section 5 discusses the results, with particular emphasis on their policy implications. Section 6 offers conclusions and policy recommendations.

2. Literature Review: Educational Efficiency and Policy Implications

2.1. Theoretical foundations of educational efficiency

The measurement of educational efficiency has deep roots in both economics and education research. Bloom (1956) and Gagné (1964) laid the groundwork by proposing institutional strategies based on well-defined learning objectives and task analysis, aimed at achieving high levels of student performance. The concept of efficiency itself gained formal analytical grounding through the work of Koopmans (1951), who introduced the notion of technical efficiency as the relationship between input variations and output changes, and Debreu (1951), who emphasized the relevance of efficiency measurement given the scarcity of resources in production processes.

Farrell (1957) provided the first comprehensive framework for efficiency analysis, decomposing it into technical efficiency—the ability to maximize output from a given set of inputs—and allocative efficiency—the ability to use inputs in optimal proportions given their prices. This decomposition has become foundational for subsequent DEA applications, as it allows researchers to distinguish between pure technical inefficiency (managerial failure) and scale inefficiency (operating at a suboptimal size).

In the education context, efficiency measurement intersects with broader debates about quality. Facundo and Rojas (1985) argued that educational systems must adapt to the cultural, regional, and ethnic particularities of their populations, and that curricular flexibility—not uniformity—is a criterion for judging

quality. Magendzo and Donoso (1992) similarly contended that quality is linked to cultural diversity and must respect heterogeneous forms of knowledge. These perspectives suggest that a purely input-output efficiency framework may miss crucial dimensions of educational value that are not captured by standardized test scores alone. However, as Hanushek (2003) demonstrated, the failure of input-based schooling policies does not imply that resources do not matter—it implies that resources matter conditionally, depending on how they are deployed and governed.

2.2. Empirical studies on educational efficiency

A substantial body of empirical work has applied efficiency measurement techniques to education. Arredondo (1983) analyzed the internal efficiency of Mexico's educational system and concluded that evaluating teaching methods and their relationship to performance levels is the most effective lever for improving quality. Shiefelbein (1984) identified factors that do not influence school performance—including class size, teacher training, and shift scheduling—a finding with profound implications for resource allocation policy. His later study (Shiefelbein, 1988) examined the external efficiency of education, linking educational attainment to labor market outcomes.

McLauchlan (2009) analyzed standardized national assessments across Latin America and called for dissemination strategies oriented toward improving pedagogical management and providing professional development opportunities for teachers and supervisors. Weiss (1998) highlighted the growing awareness that evaluation results must contribute to systemic improvement—a principle that remains inadequately implemented in Mexico. Caracas and Ornelas (2019) explored PISA and ENLACE results to identify the most frequent errors in reading comprehension and proposed pedagogical strategies for classroom improvement.

DEA-specific applications to education include Piñeros (2010), who analyzed the Colombian official education system using CRS and VRS models; Thieme (2005), who examined the determinants of educational efficiency using contextual and controllable variables; Iregui, Melo, and Ramos (2006), who used econometric models to assess education efficiency in Colombia; and Rodríguez (2014), who applied frontier analysis to higher education in Colombia. In the Mexican context, Becerril, Álvarez, and Nava (2012) analyzed the technological frontier and technical efficiency of higher education, while Gómez (2013) studied educational efficiency in Michoacán using a municipal education index. Torres, Navarro, and Gómez (2012) extended this analysis to the main cities of Michoacán.

2.3. Policy context: The evolution of evaluation in Mexico

Mexico's evaluation architecture has undergone significant transformations. ENLACE, administered from 2006 to 2013, became the country's largest standardized assessment instrument, but its accountability-driven design generated perverse incentives (Backhoff, 2018). Martínez (2015) conducted a comprehensive validation study of ENLACE and EXCALE, recommending a shift toward diagnostic evaluation. PLANEA, introduced in 2015, aimed to correct ENLACE's deficiencies by emphasizing formative assessment, yet its results have been equally disappointing in terms of learning outcomes (INEE, 2017).

Jiménez (2016) argued that Mexico's embrace of large-scale evaluation is driven less by pedagogical concerns than by international competitiveness pressures—a critique that resonates with the broader literature

on the political economy of education reform. Rubio and Farías (2013) explored school effects in Mexico City using value-added models, while Campos and Urbina (2011) demonstrated that classroom-level learning, as measured by bimestral assessments, correlates strongly (0.84 standard deviations) with ENLACE results, validating the use of standardized tests as output measures in efficiency studies.

Moran (2019) analyzed educational inequality and its intersection with the 2019 constitutional reform, noting that while the reform eliminated the INEE, it did not address the structural factors—resource misallocation, regional disparities, modality-specific gaps—that perpetuate low performance. This policy vacuum creates an urgent need for evidence that can guide targeted intervention strategies, which is precisely the contribution this study aims to make.

3. Methodology

3.1. Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric linear programming method that constructs an efficiency frontier from observed decision-making units (DMUs), each characterized by a combination of inputs and outputs, and determines their relative efficiency (Charnes, Cooper, & Rhodes, 1978; Coll & Blasco, 2006). Unlike parametric approaches, DEA does not require a priori specification of the production function, making it particularly suitable for the complex, multi-input, multi-output nature of educational production.

3.1.1. Technical efficiency: The CCR model

The foundational DEA model, proposed by Charnes, Cooper, and Rhodes (1978), assumes constant returns to scale (CRS). Under this assumption, a proportional change in input levels leads to a proportional change in output. The CRS model in its envelopment form can be expressed as:

Min θ_o
Subject to:
$\Sigma\lambda_j x_{ij} \leq \theta_o x_{io}$ for all i
$\Sigma\lambda_j y_{rj} \geq y_{ro}$ for all r
$\lambda_j \geq 0$ for all j

where θ_o indicates the distance in inputs to the efficiency frontier (i.e., the efficiency measure), X is the input matrix, Y is the output matrix, λ_j are intensity weights, and x_{io} and y_{ro} represent the input and output values of the DMU under evaluation, respectively. A DMU is efficient when $\theta_o = 1$, and all slack variables are zero.

3.1.2. The BCC model and pure technical efficiency

Banker, Charnes, and Cooper (1984) extended the original model to accommodate variable returns to scale (VRS), recognizing that factors such as imperfect competition and financial constraints may prevent DMUs from operating at optimal scale. The VRS model adds the convexity constraint $\Sigma\lambda_j = 1$, which ensures that an inefficient unit is only compared with units of similar size. The efficiency measured under VRS is termed pure technical efficiency (PTE), as it excludes scale effects (Thanassoulis, 2001).

The decomposition of efficiency is as follows:

Global Technical Efficiency (CRS) = Pure Technical Efficiency (VRS) × Scale Efficiency

Scale efficiency measures the impact of DMU size on productivity. It is computed as the ratio of CRS efficiency to VRS efficiency. If both measures coincide for a given DMU, no scale inefficiency exists; the difference between them quantifies the scale inefficiency (Coll & Blasco, 2006).

3.2. Slack analysis

Slack analysis identifies potential improvements in both inputs and outputs for inefficient DMUs. Input slacks represent the amount by which an input can be reduced without reducing outputs, while output slacks represent the amount by which an output can be increased without requiring additional inputs. Following Coll and Blasco (2006), the slack analysis reveals the specific adjustments each inefficient unit must make to reach the efficiency frontier. This information is particularly valuable for policy purposes, as it pinpoints which resources are overused and which outcomes are underproduced in each service modality.

4. Model Development and Data

4.1. Decision-making units and data sources

The DMUs for this study are Mexican municipalities that provide all three modalities of lower secondary education: general schools, technical schools, and telesecundarias. According to INEGI data, Mexico has 2,457 municipalities, of which 2,243 (91.29%) offer at least one secondary education service. However, data availability constraints—specifically, the non-universal application of standardized tests across municipalities—reduced the sample size for each year-modality combination, as shown in Table 1.

Table 1.

Number of municipalities with available test data, by year and service modality.

Assessment	Year	General	Technical	Telesecundaria
ENLACE	2010	912	976	1,530
ENLACE	2011	350	983	1,459
ENLACE	2012	980	920	1,504
ENLACE	2013	916	984	1,534
PLANEA	2015	928	831	1,199
PLANEA	2017	870	934	1,486

Source: Author's elaboration based on SEP, 2017.

4.2. Input and output selection

The selection of inputs and outputs was guided by a systematic review of the efficiency measurement literature in education (Table 2), as well as by data availability from the National System of Educational Statistics (SNIEE, Format 911) and the ENLACE/PLANEA databases.

Table 2.

Literature review of input-output variables in educational efficiency studies.

Author(s)	Methodology	Inputs	Outputs
Piñeros (2010)	DEA CRS & VRS	School type, zone, enrollment, teacher education, % GDP spending, teacher professionalization by zone	Standardized test scores, Reproval rate, Promotion rate
Rodríguez (2014)	Tobit model	Economic variables, infrastructure, student age, shift modality, financing	Standardized test scores, Dropout reduction
Iregui, Melo & Ramos (2006)	Econometric model	Total education spending, funding sources, enrollment, public spending per student, coverage rate, number of institutions	Quality indicators, Terminal efficiency, Dropout reduction, ICFES scores
Thieme (2005)	DEA	Contextual (literacy rate, GDP, economically active population, math/science indices); Controllable (teacher count, teacher quality, facilities)	Standardized test scores, Math/science indices
Torres, Navarro & Gómez (2012)	DEA	Total enrollment, teaching staff, schools and groups served	Approved students, Student attendance/persistence
Becerril, Álvarez & Nava (2012)	DEA	Higher education inputs	Higher education outputs, Technological frontier

Source: Author's elaboration based on Carvallo (2006), Gómez (2013), Thieme (2005), Iregui, Melo & Ramos (2006), Rodríguez (2014), Piñeros (2010), Becerril, Álvarez & Nava (2012).

Based on the available variables, the final model specification is as follows:

Inputs:

- Budget allocated to secondary education (PRES)
- Number of schools (ESC)
- Total student enrollment (ALUM)
- Number of teachers (DOC)
- Administrative staff (PA)

Outputs:

- Number of students achieving proficiency levels III (good) and IV (excellent) in Spanish (ESP)
- Number of students achieving proficiency levels III (good) and IV (excellent) in Mathematics (MAT)

Available variables from SNIEE, ENLACE, and PLANEA.

Inputs: Schools, Total enrollment, Male enrollment, Female enrollment, Teachers, Male teachers, Female teachers, Grade 1–3 enrollment (by gender), New entrants, Total staff, Administrative and other specialized staff, Total groups

Outputs: Average Spanish score, Average Mathematics score, Proficiency levels (insufficient, elementary, good, excellent) for both Spanish and Mathematics, Repetition totals by grade

All input-output correlations are statistically significant at the 1% level and exceed 0.90, confirming strong linear relationships suitable for DEA modeling. The model employs output orientation, as the policy objective is to maximize learning outcomes given existing resource levels rather than to minimize inputs.

5. Results and Policy Analysis

5.1. Overall efficiency of Mexican lower secondary education

The DEA results show systematic inefficiency in Mexican lower secondary education. Across all municipalities, years, and modalities, the average global technical efficiency (CRS) was 0.175, meaning that the typical municipality produces 17.5% of the learning outcomes that would be achievable with its current resource endowment under efficient management. Pure technical efficiency (VRS) averaged 0.270, while scale efficiency averaged 0.630. These scores indicate that, although scale inefficiency contributes to overall inefficiency, pure managerial inefficiency—the difficulty of converting available inputs into maximum outputs—is the dominant constraint.

From a policy perspective, these results question the logic that has governed Mexican education spending for decades. The implicit assumption of input-expansion policies has been that more resources—more schools, more teachers, and larger budgets—will automatically produce better learning outcomes. The DEA evidence does not support this assumption: the system is constrained not only by the quantity of inputs, but by the effectiveness with which existing inputs are deployed. This finding aligns with Hanushek's (2003) argument that input-based schooling policies tend to fail when they do not address how resources are used.

5.2. Efficiency by service modality

Table 3 summarizes the VRS technical efficiency scores for the three service modalities. Technical schools achieved the highest average score (0.330), followed by telesecundarias (0.255) and general schools (0.251). The year 2013 represented a convergence point, with the highest efficiency level for all three modalities, while 2015 marked the lowest point across modalities.

The policy implications of this modality ranking are significant. General schools, which receive the largest budget allocations, employ the most teachers, and operate the most facilities, show the lowest average VRS efficiency. Technical schools, operating with fewer resources and a more vocationally oriented curriculum, achieve better results per unit of input. Telesecundarias, despite receiving the lowest funding, reach efficiency levels close to those of general schools, which underscores the importance of organizational and contextual factors in educational productivity.

Table 3.

Average VRS Technical Efficiency by Service Modality and Year (2010–2017)

Year	General Schools	Technical Schools	Telesecundarias
2010	0.225	0.290	0.235
2011	0.210	0.270	0.220
2012	0.270	0.350	0.300
2013	0.350	0.400	0.350
2015	0.180	0.220	0.190
2017	0.270	0.450	0.240
Average (2010–2017)	0.251	0.330	0.255

Source: Author's DEA calculations based on ENLACE and PLANEA data.

5.3. General schools: The paradox of resource abundance

General schools represent the largest and most resource-intensive modality. Their VRS efficiency trajectory shows a peak in 2013, a marked decline in 2015, and a partial recovery in 2017. The evidence suggests that the main challenge is not only the size of the school system, but the way resources are organized and transformed into learning outcomes within municipalities.

The slack analysis (Table 12) reveals that general schools have the largest input excesses across virtually all variables: an average surplus of 7.769 schools, 639.650 students, 32.068 teachers, and 26,456.661 thousand pesos in budget per municipality. These slacks indicate that a substantial portion of the resources allocated to general schools is not translating into improved learning outcomes. The output slacks—176.275 additional students in Spanish and 100.363 in Mathematics—quantify the gap between current and achievable performance.

5.4. Technical schools: Relative efficiency, absolute challenges

Table 4.

Global Technical Efficiency, Pure Technical Efficiency, and Scale Efficiency of Technical Schools in Mexico, 2010–2017

Year	Global Technical Efficiency (CRS)	Pure Technical Efficiency (VRS)	Scale Efficiency
2010	0.210	0.270	0.780
2011	0.220	0.290	0.770
2012	0.250	0.320	0.780
2013	0.340	0.410	0.820
2015	0.150	0.260	0.580
2017	0.330	0.430	0.770
Average	**0.250**	**0.330**	**0.750**

Source: Author's DEA calculations based on ENLACE and PLANEA data.

Technical schools outperform the other two modalities across most years, with their highest VRS efficiency score recorded in 2017. However, an average VRS efficiency of 0.330 means that even the best-performing modality operates well below the efficiency frontier. The slack analysis identifies administrative staff as the primary input excess, with an average surplus of 10.580 per municipality, suggesting that administrative overdeployment, rather than pedagogical inputs alone, is an important source of inefficiency in this modality.

This finding has a clear policy implication: the technical school model appears to generate better learning outcomes per unit of pedagogical input, but its administrative structure may be oversized relative to its educational output. Streamlining administrative processes in technical schools could yield efficiency gains without reducing educational quality.

5.5. Telesecundarias: Doing more with less—but not enough

Table 5.
Global Technical Efficiency, Pure Technical Efficiency, and Scale Efficiency of Telesecundarias in Mexico, 2010–2017

Year	Global Technical Efficiency (CRS)	Pure Technical Efficiency (VRS)	Scale Efficiency
2010	0.156	0.220	0.710
2011	0.149	0.210	0.710
2012	0.197	0.270	0.730
2013	0.332	0.400	0.830
2015	0.102	0.160	0.640
2017	0.200	0.260	0.770
Average	**0.189**	**0.253**	**0.732**

Source: Author's DEA calculations based on ENLACE and PLANEA data.

Telesecundarias present a paradox that is central to Mexico's educational equity challenge. Operating with the lowest budget allocations and the fewest teachers per municipality, they achieve efficiency levels similar to those of general schools. Their slack profile shows lower absolute input excesses (1.717 schools, 43.705 students, 4.689 teachers, and 1,140.547 thousand pesos in budget), as well as the smallest output gaps (4.590 in Spanish and 15.151 in Mathematics).

However, efficiency scores near 0.255 should be interpreted with caution: they indicate that the modality remains far from the efficiency frontier. The telesecundaria model, designed to extend educational access to rural and marginalized communities, cannot compensate for chronic underfunding through organizational efficiency alone. Policy interventions must address both resource deficits and the pedagogical challenges specific to distance and semi-presential education models.

5.6. Municipal efficiency patterns

Tables 6 through 11 present the municipalities that achieved full efficiency (score = 1) across all three DEA models in 2013 (ENLACE) and 2017 (PLANEA). Several patterns emerge with policy relevance:

First, efficient municipalities are disproportionately located in states with lower average development levels (Guerrero, Puebla, Veracruz), which may reflect the fact that DEA measures relative efficiency—small, resource-constrained schools in these states may be operating closer to their frontier precisely because they have less room for waste. Second, the geographic concentration of efficient municipalities shifts between assessment periods: Guerrero dominates in 2013, while Coahuila, Puebla, and Tamaulipas emerge in 2017. This shift may reflect changes in test administration, data coverage, or genuine improvements in specific regions.

Third, the very small number of fully efficient municipalities (ranging from 7 to 13 per modality-year combination out of hundreds of DMUs) confirms that the efficiency problem is systemic, not localized. No single state or region has discovered a replicable formula for converting educational inputs into learning outcomes at optimal levels.

Table 6.

Municipalities with full technical efficiency (ENLACE 2013, General schools).

State	Municipality	GTE	PTE	SE
Guerrero	Coyuca de Catalán	1	1	1
Guerrero	Cutzamala de Pinzón	1	1	1
Guerrero	Tlapehuala	1	1	1
Jalisco	Talpa de Allende	1	1	1
México	Axapusco	1	1	1
Morelos	Tetela del Volcán	1	1	1
Nuevo León	Cadereyta Jiménez	1	1	1
Puebla	Tlahuapan	1	1	1
Tabasco	Cunduacán	1	1	1
Veracruz	Cosoleacaque	1	1	1
Veracruz	Zongolica	1	1	1

Source: Author's DEA calculations.

The efficient technical school municipalities under ENLACE 2013 are more geographically concentrated in Guerrero, Puebla, Veracruz, and the State of Mexico than the general school benchmark. This distribution suggests that the technical modality was capable of reaching the DEA frontier in both small and medium-size municipalities, indicating a relatively stronger match between educational inputs and learning outcomes in specific local contexts; please see Table 7.

Table 7.

Municipalities with full technical efficiency (ENLACE 2013, Technical schools).

State	Municipality	GTE	PTE	SE
Guerrero	Alcozauca de Guerrero	1	1	1
Guerrero	Coyuca de Catalán	1	1	1

Hidalgo	Zempoala	1	1	1
México	San Mateo Atenco	1	1	1
México	Temascaltepec	1	1	1
Puebla	Libres	1	1	1
Puebla	San Salvador El Seco	1	1	1
San Luis Potosí	San Antonio	1	1	1
Sonora	Álamos	1	1	1
Veracruz	Catemaco	1	1	1
Veracruz	San Andrés Tuxtla	1	1	1
Veracruz	Santiago Tuxtla	1	1	1

Source: Author's DEA calculations.

For telesecundarias in 2013, full efficiency appears in a more heterogeneous group of municipalities, including northern, central, and southern states. This pattern indicates that the telesecundaria modality can reach frontier performance under different territorial conditions, although these cases remain exceptional relative to the total number of municipalities evaluated; please see Table 8.

Table 8.

Municipalities with full technical efficiency (ENLACE 2013, Telesecundarias).

State	Municipality	GTE	PTE	SE
Coahuila	Sierra Mojada	1	1	1
Chihuahua	Buenaventura	1	1	1
Guerrero	Cualac	1	1	1
Guerrero	Petatlán	1	1	1
México	Huehuetoca	1	1	1
Morelos	Jiutepec	1	1	1
Morelos	Jonacatepec	1	1	1
Puebla	Ixcaquixtla	1	1	1
Sonora	Ures	1	1	1
Tabasco	Comalcalco	1	1	1
Tabasco	Teapa	1	1	1

Source: Author's DEA calculations.

The 2017 PLANEA results for general schools show a shift toward urban and industrial municipalities, particularly in Coahuila, Ciudad de México, Nuevo León, and Tamaulipas. This change suggests that, by 2017, full efficiency in the general school modality was concentrated in municipalities with stronger institutional capacity and more consolidated educational infrastructure; please see Table 9.

Table 9.

Municipalities with full technical efficiency (PLANEA 2017, General schools).

State	Municipality	GTE	PTE	SE
Coahuila	Monclova	1	1	1
Coahuila	Piedras Negras	1	1	1
Ciudad de México	Miguel Hidalgo	1	1	1
Nuevo León	Sabinas Hidalgo	1	1	1
Tamaulipas	Nuevo Laredo	1	1	1
Tamaulipas	Tampico	1	1	1
Ciudad de México	Azcapotzalco	1	1	1

Source: Author's DEA calculations.

In the 2017 technical school results, fully efficient municipalities are distributed across several states, with a notable presence of Puebla, the State of Mexico, San Luis Potosí, Jalisco, Durango, and Veracruz. The recurrence of municipalities such as Libres and San Salvador El Seco across periods suggests that some local technical school systems maintained a relatively consistent ability to convert educational inputs into achievement outcomes; please see Table 10.

Table 10.

Municipalities with full technical efficiency (PLANEA 2017, Technical schools).

State	Municipality	GTE	PTE	SE
Durango	Tepehuanes	1	1	1
Jalisco	Talpa de Allende	1	1	1
México	Polotitlán	1	1	1
México	Xonacatlán	1	1	1
Puebla	Libres	1	1	1
Puebla	Quecholac	1	1	1
Puebla	San Salvador El Seco	1	1	1
Puebla	Tlacotepec de Benito Juárez	1	1	1
San Luis Potosí	Moctezuma	1	1	1
San Luis Potosí	San Martín Chalchi-cuautla	1	1	1
Veracruz	Gutiérrez Zamora	1	1	1

Source: Author's DEA calculations.

For telesecundarias in 2017, efficient municipalities again show a broad territorial distribution, with several cases in Puebla and additional municipalities from Coahuila, Hidalgo, Jalisco, the State of Mexico, and Sonora. These results support the interpretation that telesecundarias can reach relative efficiency in diverse

contexts, although the number of frontier cases remains small and does not eliminate the broader evidence of systemic inefficiency; please see Table 11.

Table 11.

Municipalities with full technical efficiency (PLANEA 2017, Telesecundarias).

State	Municipality	GTE	PTE	SE
Coahuila	Sierra Mojada	1	1	1
Hidalgo	Huichapan	1	1	1
Hidalgo	Tizayuca	1	1	1
Jalisco	San Miguel el Alto	1	1	1
Jalisco	Totatiche	1	1	1
México	Ixtapan de la Sal	1	1	1
México	Tequixquiac	1	1	1
Puebla	Ixcaquixtla	1	1	1
Puebla	Quecholac	1	1	1
Puebla	Tehuacán	1	1	1
Puebla	Tepanco de López	1	1	1
Sonora	Agua Prieta	1	1	1
Puebla	San Miguel Xoxtla	1	1	1

Source: Author's DEA calculations.

5.7. Slack analysis and resource misallocation

Table 12 presents the average slack values for 2017 across the three modalities. The interpretation is straightforward: negative values indicate input excess (resources that could be reduced without reducing outputs), while positive values indicate output shortfalls (additional achievement that could be realized without additional inputs).

Table 12.

Slack analysis by service modality (2017).

Modality	Schools	Students	Teachers	Admin. staff	Budget (000s)	Spanish	Math
General	-7.769	-639.650	-32.068	-3.753	-26,456.661	176.275	100.363
Technical	-0.437	-43.459	-12.843	-10.580	-1,134.222	0.510	21.558
Telesec.	-1.717	-43.705	-4.689	-1.845	-1,140.547	4.590	15.151

Source: Author's DEA calculations. Negative values = input excess; Positive values = output shortfall.

The policy implications of the slack analysis are important. General schools, despite receiving the largest budgets and operating the most extensive infrastructure, exhibit the largest input excesses: an average of 7.8 surplus schools, 639.7 surplus students, 32.1 surplus teachers, and 26,456.7 thousand pesos in surplus

budget per municipality. Meanwhile, 176.3 additional students could reach proficiency in Spanish and 100.4 in Mathematics if resources were reallocated efficiently. This configuration suggests that input accumulation has not translated into proportional learning gains.

Technical schools show a distinctive pattern: their primary inefficiency source is administrative staff overdeployment (10.580 surplus per municipality), while their pedagogical input slacks are comparatively modest. This suggests that the technical school model achieves better pedagogical efficiency but faces administrative inefficiency.

Telesecundarias, with the smallest absolute slacks across all dimensions, operate closest to their efficiency frontier; however, this partly reflects their limited resource base. The output slacks (4.6 in Spanish and 15.2 in Mathematics) are small in absolute terms but substantial in relative terms given the already low baseline performance of these schools.

6. Conclusions and Policy Recommendations

This study has employed Data Envelopment Analysis to evaluate the technical efficiency of Mexican lower secondary education at the municipal level from 2010 to 2017, covering three service modalities—general schools, technical schools, and telesecundarias—using budget, schools, enrollment, teachers, and administrative staff as inputs and standardized proficiency levels in Spanish and Mathematics as outputs. The results are unequivocal: the system operates far below its production frontier, with average global technical efficiency of 0.175, pure technical efficiency of 0.270, and scale efficiency of 0.630.

The central finding—that Mexico's lower secondary education system converts only 17.5% of its potential output into measurable learning outcomes—demands a fundamental rethinking of education policy. The evidence presented here supports five specific policy recommendations:

Recommendation 1: Shift from input expansion to outcome-oriented governance.

The prevailing policy approach in Mexico has been to increase inputs—more schools, more teachers, larger budgets—under the assumption that these will automatically generate better results. The DEA evidence does not support this assumption. Pure technical efficiency (0.270) is lower than scale efficiency (0.630), indicating that managerial and organizational inefficiency is a more serious constraint than scale. Policy should focus on improving how resources are used, not merely on increasing their quantity. This requires establishing clear outcome targets tied to resource allocation, with accountability mechanisms that reward efficiency gains rather than input accumulation.

Recommendation 2: Implement modality-specific resource strategies.

The three service modalities exhibit fundamentally different efficiency profiles and slack patterns. General schools need to reduce administrative overhead and improve pedagogical productivity. Technical schools should streamline their bureaucratic apparatus while preserving their pedagogical model. Telesecundarias require targeted investment in pedagogical support, teacher training for distance education, and digital infrastructure to overcome their chronic underfunding. A one-size-fits-all policy cannot address the distinct challenges of each modality.

Recommendation 3: Strengthen the link between evaluation and policy improvement.

Mexico's experience with ENLACE and PLANEA shows that evaluation alone does not drive improvement. As McLauchlan (2009) and Weiss (1998) have argued, evaluation results must be connected to pedagogical strategies, professional development, and institutional learning. The dissolution of INEE in 2019 and the institutional uncertainty it created make this recommendation even more urgent. A new evaluation governance framework must ensure that assessment data feeds directly into school improvement cycles, resource reallocation decisions, and teacher professional development programs.

Recommendation 4: Address regional disparities through targeted reallocation.

The geographic distribution of efficient municipalities reveals that some of the most resource-constrained regions (Guerrero, Puebla, Veracruz) occasionally achieve efficiency scores of 1.0, suggesting that organizational factors—not just resource quantity—matter. Policy should study these efficient outliers to identify transferable practices, while simultaneously addressing the structural underfunding of telesecundarias and rural schools. The shift from ENLACE to PLANEA also changed the geographic pattern of efficiency, suggesting that assessment design and coverage significantly influence efficiency measurement and must be standardized for longitudinal comparability.

Recommendation 5: Invest in teacher professionalization and curriculum relevance.

The theoretical literature consistently emphasizes that curriculum relevance and teacher quality are more determinative of learning outcomes than input quantities (Adams & Aarto, 1975; Postman & Weingartner, 1969; Carvallo, 2006). The finding that general schools—with the most teachers—achieve the lowest efficiency confirms that teacher quantity without teacher quality and curriculum alignment cannot produce results. Mexico should redirect a portion of its current input spending toward teacher professional development programs, competency-based curriculum reform, and context-sensitive pedagogical materials that connect learning to students' lived realities.

In conclusion, this study demonstrates that the efficiency crisis in Mexican lower secondary education is not only a problem of insufficient resources; it is also a problem of systemic misallocation. The DEA methodology indicates that the same or better learning outcomes could be achieved with substantially fewer inputs if resources were deployed more effectively. The path forward requires not only higher spending, but better-directed spending: outcome-oriented governance, modality-differentiated strategies, and a renewed commitment to ensuring that educational resources reach schools in ways that produce measurable learning outcomes.

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