

REINVENTING STEM PATHWAYS IN MEXICAN UNIVERSITIES

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Abstract

Mexican higher education is facing a turning point in STEM fields (Science, Technology, Engineering, and Mathematics). In several public universities, both demand and graduation efficiency show clear signs of weakening, even as the global productive environment increasingly requires highly qualified technological profiles. This article analyzes how university training can be aligned with Mexico's emerging technological needs, drawing on the case of the Universidad Autónoma Metropolitana (UAM), Azcapotzalco campus, and its Division of Basic Sciences and Engineering (DCBI). A quantitative-documentary and institutional approach is adopted, combining internal statistics (2017–2024) on applicants, admitted students, and graduates with administrative records related to academic interruptions, the rigidity of the trimester-based model, academic tutoring, and faculty aging. The data show that at UAM Azcapotzalco, the number of applicants decreased from 28,682 in 2017 to 21,525 in 2023, while within the DCBI the number of graduates fell from 679 in 2018 to 442 in 2022. It is argued that this trend cannot be explained solely by external shocks (e.g., the pandemic), but rather by internal dynamics that affect academic trajectories, time to degree completion, perceptions of institutional stability, and linkages with the productive sector. In a context of nearshoring, digitalization, and advanced manufacturing (World Economic Forum, 2023), the article proposes four lines of transformation: flexible, competency-based pathways with certifiable intermediate exits; hybrid and work-integrated programs; strategic use of artificial intelligence for tutoring, early detection of academic lag, and curricular updating; and more transparent, employability-oriented university–industry partnerships.

Keywords: *STEM education, public universities, engineering, academic innovation, UAM.*

1. Introduction

Public universities have historically been a cornerstone of scientific and technological training in Mexico. For decades, STEM pathways functioned as a privileged channel for social mobility and for the consolidation of national productive capacities. However, the contemporary environment combines new and simultaneous pressures: technological acceleration, reconfiguration of global value chains, automation, artificial intelligence, energy transition, and a growing demand for transversal skills such as analysis, complex problem solving, and interdisciplinary collaboration. At the same time, signs of weakening STEM pathways can be observed in certain institutions, including declining relative demand, persistent academic lag, extended time to graduation, and a loss of attractiveness when compared with generational expectations that prioritize flexibility, applied learning, and early connections to real work experience (OECD, 2023).

The case of the Universidad Autónoma Metropolitana (UAM), particularly the Azcapotzalco campus and its Division of Basic Sciences and Engineering (DCBI), is illustrative because it combines academic reputation, a strong engineering tradition, and an organizational model with historical strengths, but also with significant rigidities. Institutional records indicate a sustained decline in both applicants and graduates—a trend that cannot be fully explained by external factors alone. From an incentive perspective, this situation is compounded by the perception of long academic trajectories—for example, an average duration exceeding six years—and relatively low initial salary expectations in some profiles (below 8,000 Mexican pesos per month), factors that may influence vocational decisions and student persistence.

This article is guided by a central question: What structural adjustments would make it possible to rebuild and strengthen STEM pathways in Mexican public universities, aligning them with the new technological and productive environment without sacrificing equity or social mission? To address this question, institutional evidence from UAM Azcapotzalco (2017–2024) is analyzed, and a set of transformations oriented toward curricular flexibility, competency-based training, hybrid integration, and productive linkage is proposed.

2. Method

A quantitative-documentary approach complemented by institutional analysis was employed. Official statistics from UAM Azcapotzalco for the 2017–2024 period were reviewed, including data on applicants, admitted students, and graduates, disaggregated by academic division (including DCBI). In parallel, administrative records related to labor stoppages and suspension of activities were analyzed, along with characteristics of the trimester-based academic model and organizational elements associated with tutoring, academic support, and faculty structure (including aging).

Additionally, a review of academic literature and international reports on STEM education, university innovation, institutional governance, and university–industry linkages was conducted (Deem et al., 2007; Marginson, 2016; OECD, 2023; UNESCO, 2021). Triangulating institutional data and literature made it possible to identify structural patterns that go beyond short-term events.

3. Results

Institutional data reveal a sustained decline in demand for admission at UAM Azcapotzalco. The number of applicants fell from 28,682 in 2017 to 21,525 in 2023, representing a reduction of nearly 25%. The persistence of this trend after the most critical phase of the pandemic suggests the presence of underlying structural factors.

Within the DCBI, the decline in graduation outcomes is even more pronounced. The number of graduates decreased from 679 in 2018 to 442 in 2022, a reduction of more than 35% in just four years. This dynamic can be interpreted as a combined signal of: (a) a weakened pipeline (fewer entrants), (b) frictions along academic trajectories (delay, failure, dropout), and (c) institutional conditions that affect pace of progress and graduation efficiency.

Among the internal factors with the greatest explanatory weight are:

1. Prolonged interruptions and perceptions of institutional instability, which affect academic continuity and decisions to remain enrolled.
2. Rigidity of the trimester-based model, which limits flexible pathways, agile reentry, and alternatives for partial certification.
3. Insufficient tutoring and academic support in programs with high mathematical complexity, where the risk of early academic lag is high and bottlenecks tend to accumulate.
4. Faculty aging and a decline in permanent hiring, which may limit curricular updating and pedagogical innovation, especially in emerging areas such as artificial intelligence, automation, and data science.

4. Discussion

The observed trend contrasts with a global context characterized by accelerated digitalization, nearshoring, advanced manufacturing, and employment reconfiguration, where STEM competencies are considered strategic (World Economic Forum, 2023). In Mexico, infrastructure challenges and climate resilience further reinforce the need for engineering capabilities. For example, in October 2025, episodes of intense rainfall caused flooding and landslides in central and eastern states, resulting in significant damage to housing and infrastructure, as documented by monitoring systems and humanitarian agencies.

At the same time, economic performance and expectations of moderate growth place additional pressure on public universities. With limited resources, institutions tend to operate with rigidities that hinder reform. According to official estimates, Banco de México reported a central GDP growth forecast of around 0.6% for 2025 (with an interval), reflecting a scenario of constrained growth and reinforcing the urgency of improving relevance and employability without increasing inequality.

Within this framework, two strategic tensions emerge. The first is a generational and expectation gap: students increasingly demand flexibility, more efficient pathways, applied learning, and early connections to real work. When training is perceived as long and weakly linked to concrete opportunities, STEM choices lose relative attractiveness (OECD, 2023). The second is a technological tension: while the expansion of AI can improve tutoring and learning, it can also degrade skills if used uncritically, generating dependence on automated solutions that may still produce errors. Therefore, the key is not simply to “use AI,” but to use it within pedagogical frameworks that ensure traceability and interpretability of results, avoiding “black box” decision-making in critical processes.

Finally, the literature on managerialism and university governance suggests that reforms lacking internal legitimacy are likely to fail; a balance between efficiency, quality, academic participation, and social mission is required (Deem et al., 2007; Marginson, 2016).

5. Proposed transformations

Based on the diagnosis, four strategic lines are proposed to “rebuild” STEM pathways in Mexican public universities.

5.1. Flexible, competency-based pathways with certifiable intermediate exits

Design modular trajectories (micro-credentials, intermediate diplomas, competency certificates) that recognize progress and reduce the “all-or-nothing” logic of the final degree. This can reduce dropout, provide early returns, and allow staged reentry without loss of progress.

5.2. Hybrid programs and work–study integration

Scale hybrid modalities (digital theory + in-person laboratories) and incorporate supervised practice components with industry or the public sector (projects, residencies, internships). The goal is to narrow the gap between curriculum and productive reality, increase motivation, and strengthen employability.

5.3. Strategic use of AI for tutoring, early detection, and curricular updating

Implement AI as a support infrastructure: personalized tutoring, early alerts for academic lag, learning analytics with transparent criteria, and recommendations for remedial pathways. This must be accompanied by data governance, privacy protection, and bias assessment (UNESCO, 2021; 2023).

5.4. More transparent, employability-oriented university–industry partnerships

Build agreements with clear goals: integrative projects, shared laboratories, curriculum committees with external participation, and transparent mechanisms for internships and placement. To avoid agenda capture, accountability mechanisms and a balance between productive relevance and academic autonomy are required.

6. Conclusions

The case of UAM Azcapotzalco shows that the weakening of STEM pathways cannot be attributed solely to external factors. The decline in applicants between 2017 and 2023, along with the reduction in DCBI graduates between 2018 and 2022, points to internal problems related to how academic trajectories are structured and to certain institutional conditions. This is particularly concerning in a context where Mexico faces growing infrastructure challenges and extreme climate events, such as flooding, while simultaneously requiring technologically trained professionals to integrate into more advanced value chains. In this scenario, the loss of attractiveness of STEM programs represents a significant risk for the country’s development.

It is concluded that rebuilding STEM pathways in public universities requires reforms oriented toward flexibility, applied learning, work–study integration, responsible use of artificial intelligence, and transparent productive linkage. Implemented at scale, these measures can restore academic and social relevance, improve graduation efficiency, and enable public universities to seize technological opportunities for national development.

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