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Design and Institutional Implementation of a Competency-Based Engineering Education Model with Simplified Assessment Frameworks

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Abstract– Engineering education faces persistent challenges in ensuring coherent competency development within institutional contexts characterized by curricular complexity, disciplinary diversity, and increasing demands for quality assurance. In such settings, traditional assessment models based on the accumulation of fragmented evidence have shown limited capacity to support meaningful continuous improvement or sustainable teaching practices. This paper presents the conceptual–operational design and institutional implementation strategy of a new competency-based education model for engineering programs developed at scale. The proposed model integrates a curriculum architecture structured through differentiated formative units, a competency-based assessment framework articulated via critical evaluation pathways, and a deliberate strategy for assessment evidence simplification. Rather than reducing academic rigor, this approach prioritizes the relevance, interpretability, and decision-making value of assessment evidence, strengthening alignment among curriculum design, evaluation practices, and the student learning experience. The model was developed through a merit-based and participatory governance process involving more than 600 faculty members and encompassing 18 engineering programs. Methodologically, this study adopts an institutional design–based research approach, focusing on the academic design decisions, governance mechanisms, and implementation strategies that underpin the model. Formal implementation will begin in August 2026 and will be accompanied by a structured experimentation phase and a semester-based continuous improvement cycle grounded in collegial analysis and collective decision-making. This work contributes to engineering education by offering a transferable methodological framework for large-scale educational transformation, emphasizing academic governance, competency-based assessment, and faculty sustainability as central dimensions of educational quality.

Keywords--engineering educational, higher education, curriculum design, academic governance, assessment simplification

I. INTRODUCTION

Engineering education is currently undergoing a phase of structural reconfiguration driven by concurrent technological, social, and organizational transformations. Higher education institutions are increasingly challenged to educate engineers capable of operating in environments characterized by high complexity, uncertainty, and rapid technological change, while maintaining rigorous academic standards and robust mechanisms for learning assurance. In this context, the revision of traditional educational models is no longer motivated solely by curricular updating, but by the pressing need to comprehensively redesign the relationships among curriculum, assessment, teaching practices, and academic governance [1–4].

One of the most persistent challenges within this transformation concerns how learning assessment is conceptualized and operationalized in engineering programs [5–7]. Across many institutional contexts, quality assurance systems have progressively evolved into practices centered on the accumulation of assessment evidence, leading to a proliferation of instruments, reports, and artifacts that, while intended to demonstrate compliance with external standards, do not always contribute meaningfully to competency development or to the effective improvement of teaching practice. This logic, often reinforced by accreditation and accountability processes, has generated increasing tensions between academic rigor, curricular coherence, and the student learning experience [8,9].

From the faculty perspective, these tensions materialize as elevated assessment workloads, redundancies across courses, and fragmentation of the formative process, which hinder the integration of knowledge, skills, and attitudes. Institutional diagnostics and consultations with key stakeholders consistently indicate that academic quality is not strengthened through the indiscriminate increase of assessment evidence, but rather through models that explicitly align three fundamental dimensions: academic rigor (understood as conceptual depth and clearly defined standards), curricular structure (a coherent design of courses, sequences, and learning trajectories), and the formative experience (contextualized, meaningful learning experiences connected to professional practice). When this balance is absent, assessment systems tend to become extensive yet weakly informative, offering limited value for pedagogical decision-making and continuous improvement [10-12].

Within the Latin American engineering education context, this challenge acquires particular relevance due to the scale of educational systems, the diversity of student trajectories, and the need to simultaneously address local demands and international accreditation standards. Transitioning toward more integrated educational models therefore requires not only innovative conceptual frameworks, but also institutional strategies capable of operationalizing these principles through sustainable curricular structures, assessment mechanisms, and teaching practices. In this sense, discussions surrounding emerging paradigms such as Education 6.0 or the use of artificial intelligence in education remain insufficient unless accompanied by concrete proposals that explain how such approaches translate into academic and organizational decisions at scale [13,14].

Against this backdrop, Tecnológico de Monterrey has progressively developed its educational model for engineering programs as an evolutionary institutional transformation rather than as a collection of isolated innovations. The model presented in this study represents an advanced phase of a process initiated in 2019, which has systematically incorporated insights derived from continuous improvement cycles, accumulated implementation experience, and analyses of relevant international trends in engineering education [15,16].

The version of the model scheduled for institutional implementation beginning in August 2026 is grounded in a curricular reorganization structured around Units of Learning with differentiated functions, a competency-based assessment framework articulated through critical evaluation pathways, and a deliberate strategy for simplifying assessment evidence. This simplification is conceived as a strategic academic decision aimed at eliminating redundancies, concentrating assessment on meaningful learning outcomes, and strengthening coherence among teaching, assessment, and learning outcomes, without diminishing academic rigor, but rather reinforcing it through clearer, more integrated, and formatively relevant criteria.

A central component of this process has been the active role of faculty in the design of the model. More than 600 professors from various engineering programs participated systematically in defining curricular structures, assessment criteria, and implementation mechanisms. This broad-based engagement not only captured disciplinary and pedagogical expertise but also functioned as a key mechanism for aligning institutional vision with everyday educational practice. From an academic governance perspective, this approach sought to ensure that the model would be operationally viable, pedagogically coherent, and sustainable over time, mitigating the common gap between formal curricular design and actual classroom implementation.

The model also incorporates institutional platforms for the recording, monitoring, and analysis of competency-based assessment, with the objective of strengthening learning-outcome traceability and supporting evidence-informed academic decision-making. Within this framework, technology, including artificial intelligence, is conceived as an enabler of regulated academic processes aligned with pedagogical criteria, rather than as a substitute for faculty judgment or an end in itself. This positioning responds to the need to integrate technological innovation within clear frameworks of academic quality, ethics, and institutional responsibility.

The purpose of this article is to document and analyze the academic and institutional design of this educational model in engineering, with particular emphasis on the principles underpinning the simplification of assessment evidence, the role of faculty as central agents of continuous improvement, and the implementation strategy that enables deployment at scale. Methodologically, the study adopts an institutional design-based research approach focused on the conceptualization, structuring, and planned implementation of an educational model on a scale. Rather than reporting empirical learning outcomes, the paper analyzes the academic design decisions, governance mechanisms, and implementation strategies that support the model, establishing a foundation for subsequent empirical evaluation. In contrast to contributions centered on abstract discussions of emerging educational trends, this study emphasizes the concrete operationalization of such principles, offering transferable insights for other higher education institutions in Latin America seeking to renew engineering education models without sacrificing academic rigor, curricular coherence, or formative quality.

The analysis developed in this study is organized around three analytical dimensions: the academic design principles that enable the simplification of assessment evidence without compromising rigor, the alignment between curricular architecture, governance, and faculty participation, and the identification of model elements with potential transferability to other institutional contexts in Latin America.

To ensure rigorous post-implementation evaluation, the model incorporates a structured set of impact indicators aligned with competency development, curricular coherence, and faculty sustainability. These include: (i) competency attainment levels measured through analytic rubrics across critical assessment pathways, (ii) normalized learning gains and performance consistency across Units of Learning, (iii) curricular coherence indices derived from alignment between intended outcomes, assessment evidence, and student performance trajectories, and (iv) faculty workload and sustainability indicators, including assessment time distribution and perceived evaluative burden. These indicators will be systematically collected through institutional platforms and analyzed longitudinally to support evidence-informed refinement of the model.

II. Conceptual-Operational Framework of the Educational Model

The design of competency-based educational models in engineering requires a conceptual framework that goes beyond declarative principles and is translated into concrete academic decisions. Contemporary literature in engineering education consistently recognizes that one of the main challenges does not lie in defining competencies or learning outcomes per se, but in the difficulty of coherently articulating the conceptual, curricular, and assessment levels of educational design, particularly in large-scale institutional contexts. Curriculum fragmentation, overlapping assessments, and the accumulation of low, formative-impact evidence have been identified as structural risks that weaken both academic quality and the sustainability of teaching practices.

Within this context, many educational innovation initiatives have prioritized the adoption of active learning methodologies, digital technologies, or emerging reference frameworks, without explicitly addressing how these initiatives are integrated into coherent academic architectures. As a result, numerous proposals remain at a declarative level or generate partial solutions that, rather than strengthening systemic coherence, increase operational complexity. From this perspective, the need for a conceptual–operational framework becomes central: the challenge is not merely to redefine what is meant by learning or competency, but to clearly establish how these constructs materialized through curricular structures, teaching practices, and learning-assurance mechanisms that are viable, scalable, and academically rigorous.

Figure 1 summarizes the conceptual–operational structure of the proposed model within an institutional design–based research perspective. The framework visualizes how core design decisions are translated into curricular structures, implementation strategies, and mechanisms for continuous improvement, establishing a foundation for subsequent empirical evaluation. The figure serves as a reference point for understanding the scope, sequencing, and internal coherence of the model presented in this study.

The educational model presented in this study is situated within this rationale and adopts an explicit stance toward these limitations. Its development is grounded in the recognition that innovation in engineering education cannot be sustained solely through the adoption of isolated methodologies or technologies but must be supported by the deliberate configuration of an academic architecture that aligns educational vision, curricular design, assessment, and institutional governance. In particular, the model assumes that academic quality emerges from systemic coherence among three interdependent dimensions: disciplinary rigor, understood as conceptual depth and academic demand; curricular structure, conceived as the intentional organization of content, sequences, and formative timelines; and the student formative experience, understood as an integrated and meaningful engagement with the learning process. This premise informs both program organization and the design of assessment and learning-monitoring mechanisms.

Based on this conceptual foundation, the model was designed to operate across eighteen engineering programs, requiring simultaneous attention to disciplinary diversity, differentiated graduate profiles, and institutional scalability demands. As part of this process, certain programs underwent adjustments in their denomination and formative scope in order to more accurately reflect the evolution of professional fields and to strengthen coherence among competencies, content, and learning trajectories. These adjustments do not constitute isolated nominal changes but rather form part of a comprehensive review aimed at aligning programs within a shared curricular architecture and under common criteria of academic quality.

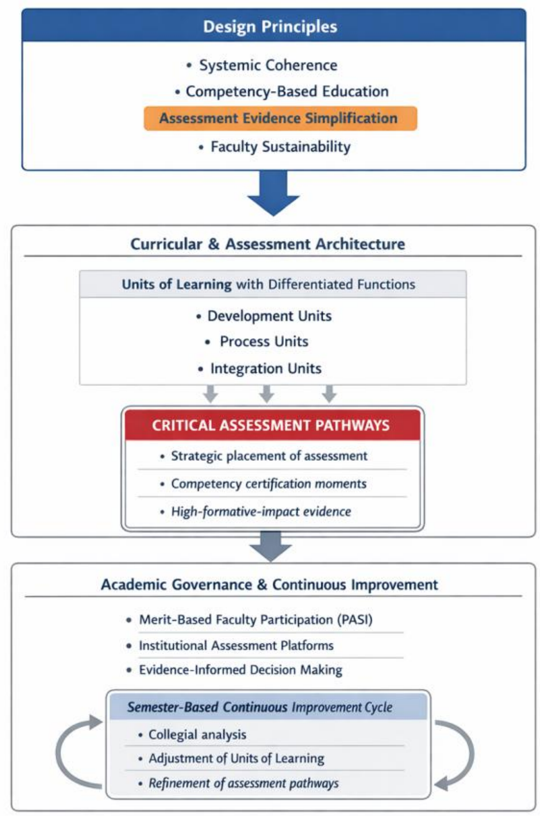

Fig. 1. Conceptual-operational framework of the institutional design-based educational model. The figure highlights the role of critical assessment pathways and strategic evidence simplification in aligning curricular architecture, governance, and continuous improvement mechanisms.

The operational core of the model lies in a curricular reorganization structured around Units of Learning with differentiated functions throughout the study plan. This organization responds to the recognition that competency development is a progressive process and that not all curricular spaces serve the same role within it. Accordingly, the model distinguishes among Units of Learning focused on the development of foundational knowledge and skills, those centered on the consolidation and application of sub-competencies, and integrative units in which complete competencies are assessed within authentic contexts. This functional differentiation enables the establishment of critical assessment pathways that clarify when and how relevant evidence of learning is collected, reducing evaluative fragmentation and strengthening both vertical and horizontal curricular coherence.

Competency-based assessment within the model is articulated through an explicit principle of assessment-evidence simplification, conceived as a strategic academic decision rather than a reduction in academic standards. In contrast to evaluative models characterized by the proliferation of low-formative-impact instruments and artifacts, the adopted approach prioritizes evidence that is valid, meaningful, and useful for pedagogical decision-making. Evidence simplification entails a deliberate departure from extensive documentation schemes that, while facilitating accountability, contribute limited value to learning analysis and teaching improvement. Instead, the model concentrates assessment at key moments of the formative process, strengthens academic feedback practices, and improves the traceability of learning outcomes at the course, program, and institutional levels, while maintaining rigorous quality standards.

The selection of assessment evidence is guided by explicit criteria, including: (i) direct alignment with competency descriptors, (ii) high formative value for feedback and learning improvement, (iii) interpretability for decision-making at course and program levels, and (iv) avoidance of redundancy across Units of Learning. Evidence that does not meet these criteria is systematically excluded, ensuring that simplification strengthens rather than weakens academic rigor.

A fundamental component of the viability of this approach has been the role of faculty in the design of the model. The designers of each Unit of Learning were selected through the Instructor Selection Assurance Program (PASI), based on criteria of teaching excellence, demonstrated disciplinary expertise, and sustained experience in delivering the content associated with each unit. This merit-based selection ensured that curricular and assessment decisions were grounded in authentic teaching practice, fostering strong alignment between formal curricular design and classroom dynamics.

Complementarily, the participation of more than 600 faculty members across the different phases of design, validation, and refinement constituted a central element of the model's academic governance. This broad and structured engagement not only strengthened the legitimacy of the model but also enabled the integration of faculty-situated knowledge into the construction of a shared framework for academic quality. From an institutional perspective, this approach reduces the gap between curricular design and implementation, enhances model sustainability, and supports adaptation across diverse disciplinary contexts without sacrificing systemic coherence.

The conceptual-operational framework of the model is completed using institutional platforms for monitoring and analyzing competency-based assessment, which facilitate process standardization, systematic management of relevant evidence, and informed academic decision-making. Within this context, technology, including artificial intelligence, is integrated as a regulated enabler of academic processes, subordinate to clearly defined pedagogical criteria and faculty professional judgment. In this way, the model articulates educational vision, curricular architecture, and academic governance into a coherent proposal oriented toward continuous improvement and formative quality in engineering programs.

From a methodological perspective, the institutional design-based research approach adopted in this study is structured across iterative cycles of analysis, design, validation, and refinement. These cycles include (i) diagnostic phases based on institutional data and faculty consultation, (ii) collaborative design workshops involving disciplinary experts, (iii) internal validation through collegial review and cross-program alignment processes, and (iv) pilot-informed adjustments during early implementation stages. Data sources include institutional records, structured faculty input, and curricular design artifacts, analyzed through qualitative thematic coding and alignment consistency criteria.

To ensure methodological rigor, the study incorporates triangulation across multiple data sources, structured validation protocols involving expert faculty panels, and consistency checks across curricular and assessment components. While the study is context-specific, these procedures aim to enhance the transparency, internal validity, and potential transferability of the proposed model.

III. Institutional Implementation Strategy and Change Management

The implementation of the educational model is conceived as a deliberate, progressive, and strategically designed institutional process aimed at ensuring academic coherence, faculty appropriation, and long-term sustainability. Unlike approaches that treat implementation as a subsequent or merely operational phase, the model explicitly recognizes that the manner in which an educational innovation is deployed decisively shapes its actual impact on learning quality and teaching practice. In large-scale institutional contexts such as the one addressed in this study, implementation constitutes an academic and organizational challenge in its own right, requiring explicit design decisions rather than ad hoc execution.

A. Phased Implementation and Academic Complexity Management.

The decision to initiate the institutional implementation of the model in August 2026 responds to the need to manage, in a controlled manner, the complexity inherent in transforming eighteen engineering programs with diverse curricular structures and a large faculty community. A phased rollout strategy enables the preservation of systemic coherence, avoiding abrupt transitions that could lead to fragmented interpretations of curricular and assessment principles. From this perspective, gradual implementation is not conceived as a postponement of change, but as an academic mechanism to protect the integrity of the design and ensure informed adoption.

This approach acknowledges that large-scale educational transformation cannot rely exclusively on curricular documents or normative guidelines. Rather, it requires spaces for progressive appropriation, feedback from teaching practice, and informed adjustments that maintain alignment with the model's foundational principles. Phased implementation facilitates the early identification of operational tensions, curricular inconsistencies, or assessment overloads, allowing corrective actions before such issues become institutionalized practices.

B. Faculty Development as a Structural Academic Policy.

A central axis of the implementation strategy is faculty development and support, conceived not as ancillary activities but as a structural academic policy. Although the design of the model was led by faculty selected based on excellence and disciplinary expertise, its effective implementation requires that the broader faculty community understand and adopt the principles underpinning curricular reorganization, competency-based assessment, and evidence simplification.

Faculty development efforts therefore focus on strengthening conceptual understanding of the model and its translation into concrete pedagogical decisions. Beyond technical training in platforms or instruments, institutional support seeks to foster a shared interpretation of the role of Units of Learning, critical assessment pathways, and the academic rationale behind evidence simplification. This approach aims to prevent the mechanical reproduction of previous assessment practices under new terminologies, a frequent risk in curricular innovation processes.

From a methodological standpoint, faculty development is conceived as a continuous process accompanying the different phases of model implementation. Systematic feedback from practice enables the identification of adoption patterns, resistance points, and reinterpretations of the model, generating valuable inputs for refinement and consolidation. In this sense, faculty development and support function as quality assurance mechanisms, contributing to coherence between formal curricular design and its effective classroom implementation.

C. Academic Governance and Evidence-Informed Monitoring.

Governance of the implementation process is supported by academic structures that facilitate coordination across programs, standardization of criteria, and systematic monitoring of the model. The use of institutional platforms for recording and analyzing competency-based assessment enables the consolidation of relevant information on learning progress, the identification of trends at course and program levels, and the support of academic decision-making grounded in pertinent evidence.

It is important to emphasize that the use of these platforms is not driven by administrative control logic, but by continuous improvement orientation. By concentrating assessment on key evidence aligned with critical pathways, the model enhances learning traceability without resorting to extensive documentation schemes. This decision reinforces coherence among assessment, feedback, and curricular design, contributing to a more informed and sustainable academic management process.

From this perspective, assessment ceases to be conceived as a discrete event and becomes integrated into a continuous cycle of analysis, feedback, and model refinement. Academic governance incorporates mechanisms for periodic review of Units of Learning, assessment criteria, and teaching practices, maintaining alignment with the model's principles while responding to evolving disciplinary and professional contexts.

D. Change Management, Risks, and Deliberate Trade-Offs.

The implementation strategy explicitly acknowledges the risks associated with educational transformation in complex institutional settings. These risks include resistance to change among some actors, operational overload resulting from partial interpretations of the model, and the tendency to replicate traditional assessment practices within new curricular structures. Rather than minimizing these risks, the model incorporates them as central considerations in implementation design.

Risk mitigation is supported by deliberate decisions regarding simplification, clear delineation of faculty responsibilities, and explicit clarification of the assessment purposes of each Unit of Learning. The formal definition of which units generate evaluative evidence and which serve predominantly formative functions represents a conscious departure from extensive assurance models based on evidence accumulation. This departure, assumed as an academic trade-off, seeks to preserve rigor and coherence in the face of administrative pressures or reductive interpretations of quality.

Change management is further supported by the legitimacy built through the participation of more than 600 faculty members in the design and validation of the model. This broad engagement not only strengthens faculty appropriation, but also operates as an informal academic regulation mechanism, fostering shared understanding of the model's principles and reducing fragmentation in implementation.

E. Scalability and Transferability of the Model

Finally, the implementation strategy is conceived with an explicit perspective of scalability and transferability. While the model is developed within the specific context of Tecnológico de Monterrey, its structural principles—systemic coherence, simplified competency-based assessment, merit-based governance, and faculty participation—address challenges shared by many engineering higher education institutions across Latin America.

The combination of a clear conceptual framework, an operational curricular architecture, and a deliberate implementation strategy constitutes a proposal that can be adapted to diverse institutional contexts, provided that its underlying principles are preserved. In this sense, the value of the model lies not only in its institutional scope, but in its potential to serve as a methodological reference for educational transformation processes seeking to balance innovation, academic rigor, and faculty sustainability.

IV. Discussion and Implications for Engineering Education.

The discussion of the results of this study must be interpreted in light of its conceptual–operational nature and institutional scope. Unlike empirical studies focused on measuring learning outcomes, this work contributes evidence derived from academic design, governance structures, and the planned implementation of a large-scale educational model. Accordingly, its primary contribution does not lie in demonstrating immediate quantifiable effects, but in offering a structured framework to address persistent challenges in engineering education that have been widely recognized in literature yet insufficiently resolved from a systemic perspective. These considerations reinforce the need to interpret engineering education as a complex, human-centered system, where learning processes emerge from the interaction of multiple academic, cognitive, and institutional variables.

A. Evidence Simplification as a High-Impact Academic Decision.

One of the central contributions of the model is the conceptualization of assessment-evidence simplification as a strategic academic decision rather than administrative optimization. The literature on competency-based assessment has extensively documented the risks associated with fragmented and overloaded evaluation systems, in which the proliferation of instruments does not necessarily translate into improved understanding of learning or effective feedback processes. In this context, the model discussed in this study explicitly departs from approaches grounded in evidence accumulation, prioritizing instead the deliberate selection of high-formative-impact evidence aligned with critical assessment pathways.

This position entails a significant conceptual shift: academic quality is no longer associated with documentary exhaustiveness, but redefined in terms of coherence, relevance, and pedagogical usefulness of assessment. From an institutional standpoint, this redefinition carries profound implications for quality assurance systems, as it challenges entrenched practices that, while facilitating accountability, impose substantial operational burdens and offer limited value for learning improvement. The discussion suggests that evidence simplification, when supported by robust curricular design and clear competency-based criteria, can simultaneously strengthen academic rigor and faculty sustainability.

B. Faculty Role and Merit-Based Academic Governance

A second distinctive feature of the model is the central role assigned to faculty as agents of design, implementation, and continuous improvement of the formative process. In contrast to top-down approaches in which curricular innovation is conceived as a normative imposition, the model analyzed here is grounded in academic governance based on merit, participation, and shared responsibility. The selection of Unit of Learning designers through explicit criteria of teaching excellence and disciplinary expertise, together with the participation of more than 600 faculty members, constitutes a mechanism of academic legitimacy that goes beyond symbolic consultation.

Organizational change literature in higher education consistently identifies faculty appropriation as a critical factor for the sustainability of educational innovation. In this regard, the model provides conceptual evidence that broad and structured faculty participation not only facilitates implementation but also functions as a regulatory mechanism that reduces interpretative fragmentation. Merit-based and participatory governance thus emerges as an essential component for aligning institutional vision with everyday teaching practice, particularly in large-scale and disciplinarily diverse contexts.

C. Curricular Architecture and Systemic Coherence.

The reorganization of the curriculum through Units of Learning with differentiated functions represents another significant contribution of the model. This curricular architecture addresses one of the most persistent challenges in engineering education: the lack of clarity regarding the role of individual courses in the progressive development of competencies. By explicitly distinguishing among units oriented toward development, process, and integration, the model provides an operational framework for coherently articulating knowledge, skills, and competencies throughout the curriculum.

From an analytical perspective, this functional differentiation facilitates alignment between curriculum and assessment by precisely delimiting the moments at which learning evidence is pedagogically and institutionally meaningful for competency certification. The discussion suggests that this approach can reduce evaluative redundancy and strengthen both vertical and horizontal curricular coherence—dimensions consistently identified as critical challenges in engineering programs characterized by complex structures and multiple learning trajectories.

D. Implications for Quality Assurance and Accreditation.

The implications of the model for quality assurance and accreditation systems are particularly relevant within the Latin American context. Traditionally, these systems have favored approaches centered on documentary demonstration of compliance, leading to extensive evaluative practices that are, in some cases, weakly connected to students' actual learning processes. The model discussed in this study proposes an alternative conceptualization that redefines the relationship among assessment, quality, and accountability.

By concentrating evaluation on key evidence aligned with critical competency pathways, the model offers a means to strengthen learning traceability without resorting to extensive documentation schemes. This approach suggests that it is possible to meet quality assurance and accreditation requirements while maintaining a pedagogically meaningful focus on learning and continuous improvement. From this perspective, the model contributes valuable elements to ongoing debates on the evolution of quality systems in engineering education, particularly in contexts where institutional scale and programmatic diversity introduce additional complexity.

E. Transferability, Limitations, and Deliberate Trade-Offs.

Although the model is developed within the specific context of Tecnológico de Monterrey, the discussion identifies elements with clear potential for transfer to other engineering higher education institutions. Systemic coherence, simplified competency-based assessment, merit-based governance, and regulated integration of technology address challenges that are widely shared across the region. Nevertheless, transferability should not be interpreted as direct replicability, but rather as the adaptation of underlying principles to distinct organizational, cultural, and regulatory contexts.

It is also important to acknowledge the limitations inherent in this study. As an analysis of design and planned implementation, empirical evidence regarding the model's impact on learning outcomes and teaching practices will only be available once implementation begins. This limitation, however, does not diminish the conceptual and methodological contribution of the work; instead, it opens clear avenues for future research focused on outcome evaluation and empirical validation of the principles discussed.

To facilitate transferability, future work will include the development of standardized templates for critical assessment pathways, exemplar Units of Learning, and samples of simplified assessment evidence. These artifacts will serve as operational references for institutions seeking to adapt the model to their own contexts.

Finally, it must be recognized that the deliberate simplification of assessment evidence entails inherent academic trade-offs. By reducing the number of evaluative artifacts, certain granular insights into student performance may be sacrificed, and opportunities for triangulation through multiple low-stakes assessments are intentionally narrowed. This risk is consciously assumed in favor of strengthening curricular coherence, improving the interpretability of assessment data, and preserving the formative role of evaluation. Within large-scale institutional contexts, the model prioritizes the depth, relevance, and decision-making value of evidence over sheer volume, arguing that an excess of fragmented data may obscure, rather than enhance, meaningful judgments about competency development.

V. Conclusions and Future Research Directions

This article has presented the conceptual–operational design and the institutional implementation strategy of a new educational model for engineering programs, conceived as a comprehensive institutional transformation aimed at strengthening curricular coherence, academic rigor, and the sustainability of teaching practice. Unlike approaches focused exclusively on the adoption of isolated technologies or methodologies, the model explicitly integrates curricular architecture, competency-based assessment, academic governance, and faculty participation, offering a systemic response to persistent challenges in engineering education.

One of the model's central contributions lies in redefining assessment as a strategically aligned process that supports competency development through the deliberate simplification of evidence and the clear delimitation of critical assessment pathways across the curriculum. This approach challenges traditional models based on the accumulation of evaluative artifacts and instead prioritizes the relevance, coherence, and formative impact of assessment practices. From an institutional perspective, this decision represents a consciously assumed academic trade-off, seeking to balance academic demand, learning traceability, and operational viability in large-scale educational contexts.

The model also underscores the central role of faculty as key agents in the design, implementation, and continuous improvement of the educational process. The selection of Unit of Learning designers based on academic merit and disciplinary expertise, together with the participation of more than 600 faculty members throughout the different phases of the process, establishes a governance scheme that strengthens the model's legitimacy and reduces the gap between formal curricular design and actual classroom implementation. This collegial participation not only facilitates faculty appropriation of the model but also constitutes a fundamental mechanism for its long-term sustainability and evolution.

In terms of implementation, the model is conceived as a progressive process that will formally begin in August 2026, followed by a structured phase of educational experimentation. This phase will enable observation of the model's performance in authentic classroom contexts, analysis of the effectiveness of Units of Learning, critical assessment pathways, and learning-monitoring mechanisms, and the generation of empirical evidence regarding its impact on competency development and teaching practice. The planned nature of this experimentation responds to the need to evaluate the model rigorously, without compromising its coherence or academic integrity.

Complementarily, the model incorporates an institutional continuous improvement cycle conducted at the end of each academic semester. This process is grounded in the systematic analysis of key challenges identified during implementation and in collegial discussion of improvement proposals among faculty, coordinators, and academic bodies. This approach recognizes that educational quality is not a static condition, but a dynamic process requiring formal spaces for reflection, adjustment, and shared decision-making. Continuous improvement is thus conceived not as a reactive correction mechanism, but as a structural component of the educational model itself.

Future research lines associated with this work are primarily oriented toward the empirical evaluation of the model once implementation begins. Subsequent studies may employ quantitative and mixed-methods designs to analyze competency development, faculty and student perceptions, and the effectiveness of assessment-evidence simplification across different engineering programs. Additional opportunities arise for comparative studies examining the adaptation of the model in other institutional contexts, particularly within Latin American higher education, where scale, programmatic diversity, and quality assurance systems pose comparable challenges.

Taken together, this work contributes to the field of engineering education by offering a robust and transferable conceptual–operational framework for large-scale educational transformation. Its primary value lies not only in the design of the model itself, but in the explicit articulation of the academic decisions, governance mechanisms, and continuous improvement processes that sustain it. In doing so, the article aims to provide substantive contributions to both academic debate and institutional practice concerning the renewal of engineering education models in contexts characterized by the need to innovate without sacrificing academic rigor, curricular coherence, or formative quality.

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