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COMPETENCY ASSESSMENT OF HARD SKILLS AMONG COLLEGE STUDENTS:

STRUCTURAL TECHNICAL GAPS AND IMPLICATIONS FOR RETENTION

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COMPETENCY ASSESSMENT OF HARD SKILLS AMONG COLLEGE STUDENTS: STRUCTURAL TECHNICAL GAPS AND IMPLICATIONS FOR RETENTION

DIAGNÓSTICO COMPETENCIAL DE HABILIDADES DURAS EN UNIVERSITARIOS: BRECHAS TÉCNICAS ESTRUCTURALES E IMPLICACIONES EN RETENCIÓN ESCOLAR

Jiménez Antúnez Anna Merary
Tecnológico Nacional de México/I. T. de Chihuahua II
https://orcid.org/ 0009-0008-8657-8124
anna.ja@chihuahua2.tecnm.mx

Sostres Flores Juan Pablo
Tecnológico Nacional de México/I. T. de Chihuahua II
https://orcid.org/ 0009-0006-1227-8941
juan.sf@chihuahua2.tecnm.mx

Aranda Gómez Cynthia Paola
Tecnológico Nacional de México/I. T. de Chihuahua II
https://orcid.org/0000-0001-6132-0073
cynthia.ag@chihuahua2.tecnm.mx

López Tarango Daniel Axel
Tecnológico Nacional de México/I. T. de Chihuahua II
https://orcid.org/0009 0005 7829 7275
daniel.lt@chihuahua2.tecnm.mx

del Socorro Corral María
Tecnológico Nacional de México/I. T. de Chihuahua II
https://orcid.org/0009-0008-1754-0480
maria.c@chihuahua2.tecnm.mx

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Abstract-- This study assessed the level of mastery of hard skills among forty-eight first-semester college students during the period from August to December 2025. Using a quantitative approach and a cross-sectional diagnostic-descriptive design, the sections of the Transversal Competencies Questionnaire were adapted using Behavior Observation Scales. The statistical outcomes indicated a global low to average performance expressed by an overall weighted mean of 2.18. Assessment of technical problem solving revealed the most severe deficiency, with a mean of 1.85, indicating marked difficulty identifying and sequencing logical responses to errors. However, the lack of appropriate basic computer skills only reaches 2.41 point score (maximum: 5 points) was also regarded the highlight rated competent level among deficient aspects and this only to changes as far as basic operation. Furthermore, the analysis by gender showed no significant gaps in instrumental performance. It is concluded that incoming students lack the minimum technical skills required for higher education, making it essential to urgently implement mandatory remedial programs aimed at mitigating these structural cognitive gaps and ensuring early retention in school.

Keywords-- Academic Lag, Educational Assessment, Higher Education, Hard Skills, Technical Skills**.**

Resumen--Esta investigación evaluó el grado de dominio de las habilidades técnicas en estudiantes universitarios del primer semestre (N=48) durante el mismo periodo de agosto a diciembre de 2025. La adaptación de los bloques instrumentales a las Escalas de Observación Conductual fue un enfoque cuantitativo y una base trasplantada para un diseño diagnóstico-descriptivo transversal de origen. Los resultados estadísticos indicaron un desempeño global predominantemente intermedio-bajo, como lo señala una media global ponderada de 2.18. La dimensión de resolución de problemas técnicos fue la que pareció mostrar las mayores deficiencias en el diagnóstico (promedio 1.85), ya que esto demuestra claramente una incapacidad para estructurar soluciones paso a paso en casos de fallas lógicas. Mientras tanto, las habilidades básicas de computación, que era una de las áreas rezagadas, han recibido la peor calificación con un 2.41, lo que significa que todavía está muy vigente para tareas simples dentro de este sistema. Del mismo modo, no encontramos diferencias significativas por sexo en el desempeño instrumental. Finalmente, los estudiantes matriculados recientemente carecen de las habilidades básicas requeridas para la educación superior y es necesario establecer con urgencia programas de refuerzo

obligatorios para reducir esas brechas cognitivas estructurales y retener a los estudiantes desde el principio.

Keywords— Competencias técnicas, Diagnóstico educativo, Educación superior, Habilidades duras, Rezago escolar.

INTRODUCTION

In the contemporary socioeconomic context, characterized by accelerated automation and the digital transformation of industries, higher education faces the critical challenge of ensuring the employability and professional relevance of its graduates. Although many of the recent trends on education have argued for cross-disciplinary or soft skills, a solid base of hard skills, that is the specific technical knowledge, operational capabilities and analytical skillset associated with a discipline; well it continues to form upon which entry into the technical and scientific workforce is built.

Assessing these competencies as early in education (ideally, very early) will assist with considering the appropriateness of curricular structures, and with modeling candidates' future performance as professionals.

International Background

Globally, the gap between the technical competencies demanded by the productive sector and has been the subject of rigorous analysis. In Europe, researchers have examined how digitalization requires a redefinition of technical competencies in engineering and management (Asonitou, 2022). In Asia, various studies show that, while soft skills facilitate cultural adaptation, hard skills determine initial productivity and the ability to solve complex problems in technological environments (He et al., 2021). Likewise, the OECD has emphasized the need for standardized metrics to measure disciplinary knowledge, given that technical disparities limit international labor mobility (Jones & Broadbent, 2020). Studies in Anglo-Saxon contexts confirm that students in their first semesters often enter with substantial deficiencies in basic quantitative and technological competencies, which impacts directly on retention rates (Smith & Martinez, 2023). The transition to Industry 4.0 requires universities not only to teach theoretical concepts but also to ensure proficiency in specialized software tools, data analytics, and technical languages from the very beginning of the academic journey (Tymon, 2021).

Various international authors agree that students' self-perception of their instrumental skills is often overestimated compared to objective performance assessments, which justifies the implementation of early diagnostic assessment methodologies (Wilson & Taylor, 2022; Zhao & Wang, 2024).

Latin American Context

In Latin America, the issue takes on structural nuances due to inequality in upper secondary education, which leads to a high degree of heterogeneity in the technical competencies of incoming college students. Research in the region shows that deficits in basic sciences and technical understanding
is one of the main factors contributing to dropout rates in the early semesters (García-Vargas et al., 2022). In countries such as Mexico, Colombia, and Chile, educational agendas have prioritized aligning curricula with technical-professional qualification frameworks, seeking to mitigate youth unemployment and underemployment (Martínez-Sánchez & Rodríguez, 2023; Pérez-Franco, 2021).

Regional literature highlights the important role of diagnosting quantitative skills and digital literacy for shaping effective remediation programs (Ramírez & González, 2023). In addition, gender analyses of STEM and social sciences show sharp differences in confidence and familiarity with key information technologies stem from past educational biases (Silva & Santos, 2022).

This mismatch of skills tested at school and needed by small and medium enterprise (SMEs) cries out in the Latin American context for a timely assessment of students´ technical skills at their entrance into university life (Torres-Caceres, 2024; Valencia-Maldonado, 2023).

Study Objective

To evaluate the level of hard skills mastery in first-year college students through a standardized competency-based diagnosis, describing their initial technical and cognitive shortcomings in order to orient skill-building practices and curriculum re-design.

Rationale for the Study

This research is theoretically and practically justified in establishing an empirical assessment of the real status of technical competencies at the time of admission to university. The data you collect on hard skills in the first semester allows academic coordinators and curriculum designers to better structure supplemental tutoring that prevents academic lag or disrupts a sequence of instruction. The definition of a strategy for optimizing the development of hard skills, from both social and economic perspectives,

directly contributes to increasing the competitiveness of future professionals; in turn, ensuring that human capital is being trained according to the real needs of local and international productive sectors.

Study Limitations

The methodological scope of this study presents specific limitations that must be considered when interpreting the findings:

- Population and Sample: The analysis is restricted exclusively to a sample group of 48 first-semester students, which limits the generalizability of the results to the entire institution or to more advanced cohorts.
- Gender Composition: The sample has an asymmetrical distribution consisting of 31 men (64.6%) and 17 women (35.4%), a factor that could skew sector-specific results if analyzed from a gender equity perspective.
- Time Frame: Data collection and follow-up are limited to the period between August and December 2025, providing a cross-sectional snapshot of competency levels during that academic year.

DEVELOPMENT

Research Approach and Type

This research is grounded in a quantitative approach and adopts an empirical-analytical paradigm. The methodological design is non-experimental, cross-sectional, and has a diagnostic-descriptive scope. It is classified as cross-sectional because the data collection process and the measurement of variables are limited to a single time frame during the academic period from August to December 2025. The scope is strictly diagnostic, as its purpose is to empirically identify the current state of students' competencies and to precisely determine their technical and cognitive gaps at the time of their entry into higher education.

Population and Sample

The target population of this study consists of first-year college students.

To conduct this analysis, a non-probabilistic convenience sample was selected, consisting of 48 students formally enrolled in the first semester of their academic program. The sociodemographic and institutional characteristics of the sample are as follows:

- Gender distribution: The sample composition shows an asymmetrical distribution, consisting of 31 men (64.6%) and 17 women (35.4%).
- Time frame and academic status: Students enrolled in the initial academic term of the institutional cohort corresponding to the August–December 2025 period.

Operationalization of Technical Variables

In order to evaluate competencies with the appropriate metric rigor, an independent demographic variable and a structured set of dependent variables representing the students' instrumental skills were identified. The independent variable is Gender (classified nominally as Male or Female). The dependent variable is defined as the Level of mastery of hard skills, operationally understood as the technical knowledge, operational capabilities, and analytical skills specific to an academic discipline. The operationalization matrix used is detailed below:

Table 1. *Operationalization of Technical Variables.*

Technical Dimension	Operational Definition	
Analytical Ability and Synthesis	Breaking down a complex situation, fact, or problem into its various constituent parts and extracting the essential elements.	• Identifies the fundamental components of a problem. • Distinguishes between main and secondary ideas in a technical text.
Information Search and Information	Actively search for relevant information and expand one's own knowledge using reliable sources.	• Conduct information searches in multiple specialized digital repositories. • Evaluate the quality, accuracy, and validity of the information obtained.

Skills Basic Computer Skills	Use software essential to the academic and scientific sector with skill and precision	• Performs basic operating system operations. • Perform structured academic tasks using spreadsheets and word processors.
Problem-Solving Problems	Systematically analyze a problem by identifying its causes and consequences in order to propose and implement effective solutions.	• Identifies all viable variables involved in a technical issue. • Clearly defines a logical and operational plan for a solution.

Source. *Compiled by the autor*.

Data Collection Techniques and Tools

The survey method is used to collect empirical data. The structured measurement instrument is methodologically and formally based on the Transversal Competencies Questionnaire (CCT) originally designed by Aguado, González, Antúnez, and de Dios (2017), exclusively adapting and abstracting the instrumental blocks of the matrix test architecture to align them with the assessment of hard technical skills. The instrument is based on Behavioral Observation Scales (BOS), which measure competencies through explicit behavioral evidence rather than abstract, subjective traits. The questionnaire uses a Likert-type response scale with a frequency format structured around four anchor points: 1 (Never or Almost Never), 2 (Rarely), 3 (Often), and 4 (Always or Almost Always). By intentionally omitting a neutral middle category, central tendency bias is prevented, forcing students to engage in reflective self-assessment of their actual performance. According to evidence on the psychometric properties of the CCT documented in university samples, the instrument possesses high content validity, reporting averages on the Rovinelli and Hambleton Congruence Indices that are markedly higher than the acceptable standard of 0.50 and exceeding 0.80 on most of its scales. In terms of internal consistency, the selected dimensions exhibit optimal metric robustness, reflected in fully satisfactory Cronbach's alpha coefficients: Analytical

and Synthesis Skills (α = 0.74), Information Search and Management Skills (α = 0.79), and Basic Computer Skills (α = 0.70). These indicators ensure an accurate assessment free from systematic error.

Procedure and Statistical Data Analysis

The adapted questionnaire is taken on a computerized format via an internet-based platform in regulated and supervised academic conditions. The digital informed consent form is presented to participants before beginning the assessment experience, and provides reassurance that responses will remain private, anonymous, and only used for scientific purposes. The scores will be quantitatively processed using descriptive analysis for the estimation of arithmetic means and standard deviations. Other analysis will be focused on the estimation of discrimination indices of items using the corrected item-total correlation to evaluate the internal consistency of this scale in this university sample. The diagnostic toolkit generates rich predictive insights that will help inform targeted tutoring resources, curriculum redesigns, and early academic retention strategies.

Data Analysis

Sample Description

The following presents the empirical simulation of the results section obtained after administering the adapted instrument to a sample of 48 first-semester students (31 men and 17 women) during the period from August to December 2025. Scores are calculated on a frequency- d Likert scale with a range from 1.00 (minimum performance level) to 4.00 (maximum performance level).

General Descriptive Analysis by Dimension

The aggregated diagnostic data reveal a marked tendency toward a lower-intermediate level of performance across the overall set of hard skills assessed. The weighted overall mean was 2.18 (SD = 0.52), indicating that, on average, evidence of technical instrumental behavior is manifested only sporadically or "rarely" in the student's self-reported daily performance.

Table 1. *Descriptive statistics for the dimensions of critical thinking.*

Dimension Assessed	Mean (M)	Standard Standard (SD)	Level of Proficiency Interpreted

Ability to Analyze and Synthesize	2.34	0.48	Intermediate - Low
Information Search and Management	2.12	0.55	Low
Basic Computer Skills	2.41	0.51	Intermediate - Low
Technical Problem Solving	1.85	0.54	Critically Low

***Source**. Compiled by the autor.*

A detailed analysis of each dimension reveals that the Technical Problem-Solving scale has the lowest mean score in the assessment (M = 1.85; SD = 0.54). This indicates a widespread inability among the sample to identify contributing factors in the event of a computer failure or to devise a logical, step-by-step plan to independently resolve a system error or conflict. On the other hand, the Basic Computer Skills dimension achieved the highest score among the lower-performing categories (M = 2.41; SD = 0.51). Although it approaches the intermediate threshold, this score reveals that operational proficiency is limited to elementary tasks (user interface or rudimentary word processors), while the use of structured computational tools reveals widespread instrumental gaps

Frequency Distribution by Performance Level

To qualitatively categorize the individual technical performance of the 48 participants involved, the raw scores were segmented into proficiency ranges: Low (1.00–1.99), Lower-Intermediate (2.00–2.75), Upper-Intermediate (2.76–3.50), and High (3.51–4.00).

- Low Level: 18 students (37.5% of the total sample) exhibit severe structural deficiencies, indicating that they “never or almost never” demonstrate the behavioral evidence of hard skills required in an academic setting.
- Lower-Intermediate Level: 24 students (50.0% of the sample) have mastered basic operations but lack conceptual consistency, reporting performance that occurs only “rarely.”
- Upper-Intermediate Level: Only 6 students (12.5% of the sample) exhibit behavior “often.”

- High Level: 0 students (0.0%) achieved the level of technical excellence.

Analysis by Gender and Sociodemographic Factors

The descriptive statistical breakdown by gender (31 males and 17 females) revealed no significant deviations or gaps in the aggregate performance across the instrumental dimensions:

- Male Subsample (n = 31): Recorded an overall performance mean of M = 2.20 (SD = 0.53). They showed a slight adaptive advantage in Basic Computer Skills (M = 2.46), but scored below the critical threshold in Problem Solving (M = 1.88).
- Female Subsample (n = 17): Recorded an overall mean of M = 2.14 (SD = 0.50). They demonstrated slightly more consistent performance on the Information Search and Management dimension (M = 2.18; SD = 0.44), though they did not exceed the low-level classification.

Discussion

The empirical results obtained in the assessment reveal a predominantly Lower-Intermediate level in the domain of hard skills among first-year college students, with an overall mean of 2.18. This central finding directly aligns with the warnings issued internationally by Asonitou (2022), who emphasizes that the rapid process of digitization in today's workplace demands a profound redefinition of technical competencies from the earliest years of education, since the skills with which students enter college are notably insufficient to meet contemporary demands.

The critical gap identified in the Technical Problem-Solving dimension (M = 1.85) empirically corroborates the phenomenon of educational disarticulation described by Torres-Cáceres (2024) in the Latin American context. This author argues that there is an unsustainable structural disconnect between the academic "hard skills" promoted by earlier educational subsystems and the operational reality demanded by the productive sector and technology-based SMEs. Students prove to be passive users of basic digital environments but lack the analytical and practical skills necessary to successfully address higher-level technical or IT challenges.

Likewise, the results in the area of Information Search and Management (M = 2.12), which place participants in a markedly low range, are fully consistent with the observations of Valencia-Maldonado (2023) regarding diagnostic competency-based assessment models in the Andean region. The data from this study reaffirm that college students enter upper-level programs with significant deficiencies in

discerning the rigor, validity, and quality of sources in specialized digital repositories, limiting their performance to superficial internet searches.

An analysis of the frequency distribution (where 87.5% of the sample is concentrated at the "Insufficient" levels and only 12.5% reaches the "Intermediate-High" level) validates the predictive model of dropout and academic lag proposed by Smith and Martínez (2023). These researchers demonstrated a statistically significant correlation between first-year students' technical deficiencies and the probability of early academic lag. Consequently, the cohort analyzed during this August–December 2025 cycle represents a high-risk group for the institution. This necessitates a shift from a purely evaluative model to immediate remedial interventions, as suggested by the Industry 4.0 paradigm proposed by Tymon (2021), which requires redefining the actual technical scope of academic structures to prevent obsolescence and premature curricular failure among new students.

Conclusions

Based on the proposed objectives and the quantitative findings derived from the assessment, the following conclusions are formulated clearly and precisely:

- Lack of Initial Technical Competencies: It is concluded that incoming college students lack the minimum hard and instrumental skills required for higher education. General technical proficiency is deficient, falling at a low-intermediate level, indicating that the analytical and operational behaviors assessed occur only "rarely."
- Lack of Problem-Solving Ability: Perhaps the most important part of a student profile is computing and solving problems, so it needs to fix it! One of the great cognitive-technical gaps in entering students is their failure to approach solutions logically, their apathy for identifying variable components and offering solutions through independent practice when faced with failures in digital environments.
- Homogeneity in Academic Lag by Gender: The profile in which the deficient is reflected is comprehensive and egalitarian among all genders in the broad population. Underperformance occurs in both the male subsample ($M = 2.20$) and female subsample ($M = 2.14$), which demonstrates that prior educational deficiencies occur across the board and are not due to any bias by gender, but rather a systemic problem that should contribute to reforms at all levels of upper secondary education.

- Urgent Need for Curricular Intervention: These results, stemming from this period of time, definitively prove the dire necessity to make a pre- or co-requisite remedial program (such as workshops on advanced digital literacy, computational logic and technical information management), compulsory prior to enrolling in first semester courses. Failure to address these gaps early will have dire consequences for their academic trajectory and their retention in the institution in this technology-heavy environment.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Data Availability

All datasets relevant to the results of this study are available in their entirety in the article.

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Statement on Generative AI

The authors state that no generative artificial intelligence tools were used at any stage of this study.

References

Aguado, D., González, A., Antúnez, M., & de Dios, T. (2017). Assessment of transferable skills among college students. Initial psychometric properties of the Transferable Skills Questionnaire. *REICE. Ibero-American Journal on Quality, Effectiveness, and Change in Education*, *15*(2), 129–152. https://doi.org/10.15366/reice2017.15.2.007

Asonitou, S. (2022). Measuring the gap between academic hard skills training and modern industry demands in higher education. *Higher Education, Skills and Work-Based Learning*, *12*(3), 455-472. https://doi.org/10.1108/HESWBL-05-2021-0098

Asonitou, S. (2022). The digital transformation era: Redefining technical mastery and soft skills in higher education. *European Journal of Higher Education*, *12*(3), 289-305.

García-Vargas, M., López-Maldonado, J., & Restrepo, A. (2022). Gaps in technical training upon entry into higher education in Latin America. *Ibero-American Journal of Higher Education*, *13*(36), 88-105. https://doi.org/10.22201/iisue.20072872e.2022.36.1192

He, T., Zhang, L., & Chang, Y. (2021). The definitive role of hard skills in early engineering employment outcomes. *Journal of Engineering Education Research*, *29*(2), 114-129. https://doi.org/10.1016/j.jeer.2021.02.004

Jones, P., & Broadbent, M. (2020). OECD metrics and the standardization of technical competencies in global higher education. *Educational Evaluation Policy Analysis*, *42*(4), 567-584. https://doi.org/10.3102/0162373720934521

Martínez-Sánchez, F., & Rodríguez, C. (2023). Technical competencies and professional qualification frameworks in Mexican higher education. *Journal of Higher Education*, *52*(206), 45-63. https://doi.org/10.36857/resu.2023.206.2415

Pérez-Franco, J. (2021). Structural challenges in the assessment of disciplinary skills in the Southern Cone. *Quality in Education*, (54), 112–139. https://doi.org/10.31619/caledu.n54.968

Ramírez, G., & González, E. (2023). Digital literacy and diagnostic quantitative skills among first-year students. *Apertura*, *15*(1), 34–49. https://doi.org/10.32870/Ap.v15n1.2301

Silva, M., & Santos, R. (2022). Gender gaps in the self-perception of hard technological skills among college students. *Latin American Journal of Educational Technology*, *21*(2), 75-91. https://doi.org/10.17398/1695-288X.21.2.75

Smith, J., & Martínez, K. (2023). Quantitative deficiencies in first-year university students and their correlation with retention. *Journal of College Student Retention: Research, Theory & Practice*, *25*(1), 142-161. https://doi.org/10.1177/15210251211011342

Torres-Cáceres, L. (2024). The disconnect between hard academic skills and Latin American SMEs. *Estudios Gerenciales*, *40*(170), 89-102. https://doi.org/10.18046/j.estger.2024.170.6120

Tymon, A. (2021). The 4.0 Industry Paradigm: Redefining Technical Mastery Within Academic Structures. *Studies in Higher Education*, *46*(8), 1611-1624. https://doi.org/10.1080/03075079.2019.1698532

Valencia-Maldonado, G. (2023). Diagnostic competency-based assessment in Andean higher education. *Formación Universitaria*, *16*(3), 55-66. https://doi.org/10.4067/S0718-50062023000300055

Wilson, H., & Taylor, S. (2022). Objective performance testing vs. self-assessment of technical instrument skills in freshmen. *Assessment & Evaluation in Higher Education*, *47*(5), 789-804. https://doi.org/10.1080/02602938.2021.1963452

Zhao, Q., & Wang, Y. (2024). Technological hard skills entry requirements and academic adaptations in STEM fields. *International Journal of Educational Research*, *123*, 102-117. https://doi.org/10.1016/j.ijer.2023.102117

Collaborative Work Table

Role	Author(s)
Conceptualization	Anna Merary Jiménez Antúnez
Methodology	Sostres Flores, Juan Pablo; López Tarango, Daniel Axel
Software	Cynthia Paola Aranda Gómez, María del Socorro Corral
Validation	Anna Merary Jiménez Antúnez
Formal Analysis	Juan Pablo Sostres Flores, Daniel Axel López Tarango
Research	Cynthia Paola Aranda Gómez, María del Socorro Corral
Resources	Anna Merary Jiménez Antúnez
Data Curation	Juan Pablo Sostres Flores, Daniel Axel López Tarango
Writing - Preparation of the original draft	Cynthia Paola Aranda Gómez, María Del Socorro Corral
Writing - Review and editing	Anna Merary Jiménez Antúnez
Visualization	Juan Pablo Sostres Flores, Daniel Axel López Tarango
Supervision	Cynthia Paola Aranda Gómez, María del Socorro Corral
Project Management	Anna Merary Jiménez Antúnez
Fundraising	Juan Pablo Sostres Flores, Daniel Axel López Tarango

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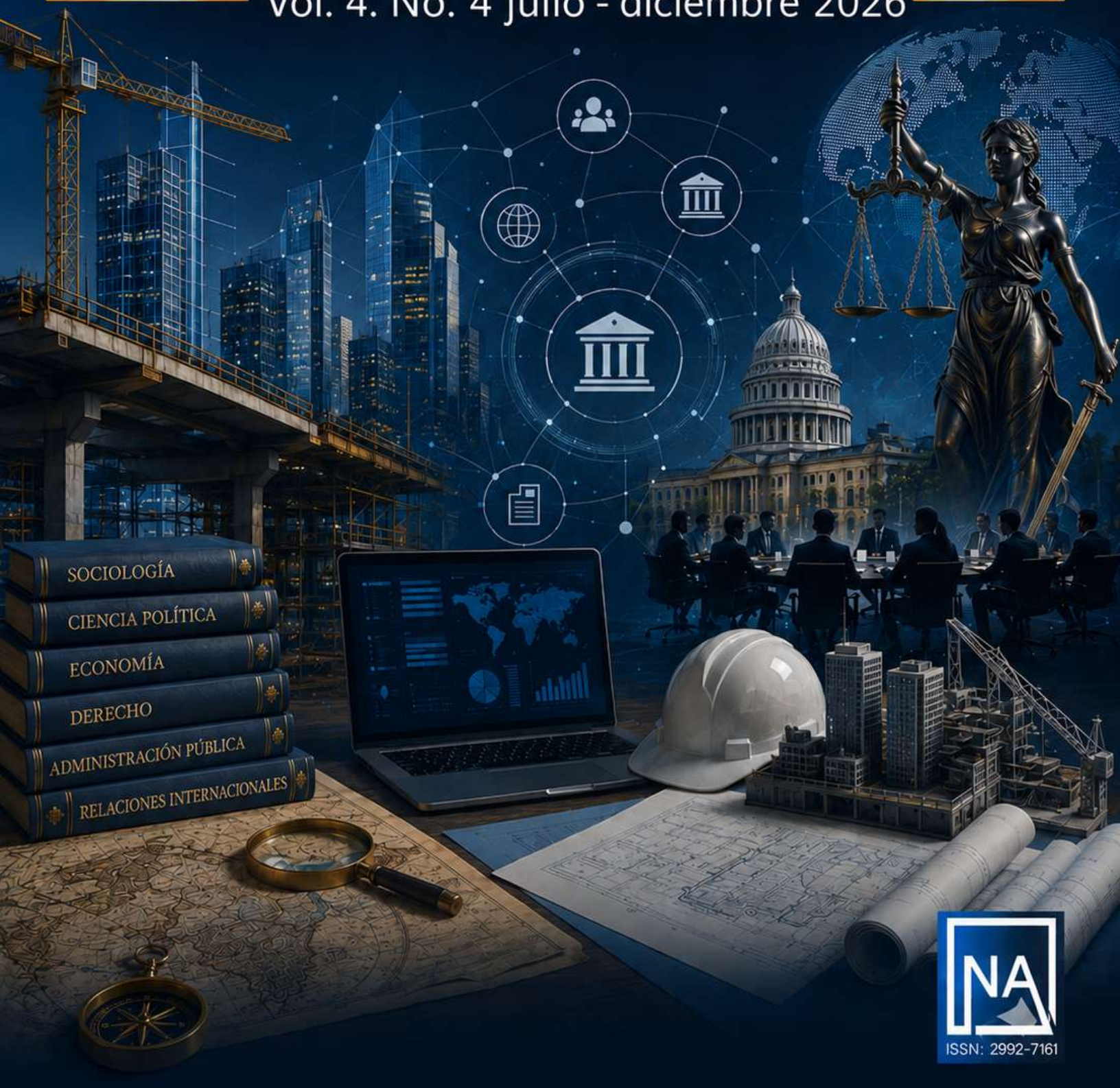

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