IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 8 Ser. 5 (August. 2026), PP 33-40
www.iosrjournals.org

Toward a Regional Standard: Minimum Competencies in Artificial Intelligence for MERCOSUR

A cross-sectional curriculum audit with evidence-informed implications for a minimum competency standard in undergraduate medical education across the expanded MERCOSUR region

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Abstract
Background: *Artificial intelligence (AI) is reshaping clinical practice, yet undergraduate medical education in the expanded MERCOSUR region lacks a feasible, assessable minimum competency standard. We aimed to characterize documented integration of AI-related and digital-health content in public medical curricula across the expanded MERCOSUR region and identify gaps relevant to future regional standard-setting.*
Methods: *We conducted a descriptive cross-sectional curriculum audit, reported following STROBE, using a secondary matrix of 131 public medical-school entries from Argentina, Brazil, Uruguay, Paraguay, and Bolivia. Publicly available curricular and regulatory documents were coded on a 0–4 ordinal scale across five domains: biotechnology/genetics, digital health/informatics, AI/bioinformatics, AI/technology ethics, and overall integration. Findings were stratified by country, with Brazil interpreted separately because its entries were coded from national curricular guidance rather than institution-specific documents. Published international frameworks, reviews, and authoritative guidance were used only to contextualize the audit findings and support discussion of a proposed minimum standard; no systematic or scoping review was undertaken.*
Results: *Of 131 matrix entries, 92 were codifiable and 39 were non-codifiable because publicly accessible documentation was insufficient. AI/bioinformatics was absent in 91 of 92 codifiable entries (98.9%), with only one partial AI-adjacent signal. AI/technology ethics did not reach partial integration in any codifiable entry: all 92 showed only tangential general bioethics. Digital health/informatics showed partial integration more frequently, although this pattern was strongly influenced by Brazil's national curricular guidance.*
Conclusions: *The curriculum audit documents a substantial regional gap in explicit AI-related undergraduate medical education. In light of these findings and existing international guidance, five priority competency areas are proposed for regional discussion: AI and data literacy; health-data governance and digital systems; critical appraisal and clinical validation; ethics, equity, and accountability; and human-centered AI use, communication, and teamwork. These areas require Delphi validation and pilot testing before adoption as a regional or accreditation standard.*
Keywords: *artificial intelligence; medical education; MERCOSUR; curriculum audit; digital health; competency-based education; AI ethics; Latin America; assessment*

Date of Submission: 15-08-2026 Date of Acceptance: 31-08-2026

I. Background

Artificial intelligence (AI) is no longer a peripheral innovation in health care. Diagnostic imaging algorithms, predictive analytics, natural language processing, clinical decision support, precision-medicine pipelines, and generative language models increasingly influence clinical information retrieval, evidence interpretation, documentation, diagnostic reasoning, and patient communication [1-3]. For undergraduate medical education, the educational question is not whether every future physician must become a programmer, but whether graduates can understand the meaning, limitations, risks, and ethical implications of AI-mediated clinical decisions.

International competency frameworks now converge around several domains: digital professionalism, health information systems, health data science, AI literacy, cybersecurity, electronic health records, computational thinking, governance, patient-facing digital health, and precision medicine [4]. Recent reviews of AI education for health professionals identify AI fundamentals, data analysis and management, ethical and legal issues, communication, teamwork, and evaluation of AI tools as essential domains [5-7], all requiring curricular integration and assessment rather than merely elective exposure. A comprehensive scoping review of 54 studies from 22 countries (Hunt et al., 2026) identified seven core domains — AI ethics, law and regulation, professionalism, clinical applications, critical appraisal of AI output, research and innovation, and theory and foundations — underscoring that the global literature is growing rapidly but remains Anglo-centric [32].

Generative AI has intensified this need. Large language models have shown potential for educational explanation, simulated cases, and licensing examination performance [8,9,28], yet can hallucinate, reproduce bias, and produce plausible but unsafe answers [10-12]. AI education must therefore teach both use and restraint. Ethics is central: privacy, consent, fairness, explainability, liability, transparency, human oversight, and justice are recurrent concerns [13,14], and general bioethics is necessary but insufficient unless translated into data governance, algorithmic bias, and technology-mediated care [15,16].

The expanded MERCOSUR region offers a compelling setting for curriculum audit and minimum-standard development. Argentina, Brazil, Uruguay, Paraguay, and Bolivia share cross-border educational mobility, public university traditions, accreditation pressures, rural-urban disparities, and unequal digital infrastructure. A curriculum audit of Spain reported that 69.2% of medical schools include no AI-related content [33], suggesting that curricular integration remains incomplete even in better-resourced settings. A regional minimum standard must avoid two extremes: a technocentric curriculum that assumes abundant infrastructure, and a minimalist curriculum that leaves graduates unprepared for AI-mediated health care. This article therefore reports a cross-sectional curriculum audit as its empirical core. Published international frameworks, reviews, and authoritative guidance are used to contextualize the findings and support discussion of a feasible minimum competency standard; they are not treated as a separate systematic or scoping review.

II. Methods

Study design and reporting standards

This study is a descriptive cross-sectional documentary curriculum audit of publicly available medical-school and regulatory documentation, reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [31]. The objective was to characterize the documented integration of AI-related and digital-health content in public undergraduate medical education across the expanded MERCOSUR region and to identify curricular gaps relevant to subsequent regional standard-setting. The literature cited in the Background and Discussion serves only as contextual support for interpretation and educational implications; no systematic or scoping review and no quantitative evidence synthesis were undertaken.

Curriculum audit

Data source and sampling frame

The empirical base was a secondary Excel matrix of 131 public medical-school entries from Argentina (n=22), Brazil (n=89), Uruguay (n=1), Paraguay (n=9), and Bolivia (n=10). Each row recorded: country, university, faculty or school, document reviewed, plan year, official URL, domain scores, pedagogical approach, overall integration level, and observations. The matrix was assembled from publicly available institutional curricula and, for Brazil, from the national curricular guidelines (Diretrizes Curriculares Nacionais, 2014 [18]), as institution-specific pedagogical projects were not uniformly available for all Brazilian schools. Representative institutional and national curricular source documents are cited in references [17-20].

Coding instrument

Domains were coded on a 0–4 ordinal scale: 0 = absent; 1 = tangential mention; 2 = partial integration; 3 = explicit, named integration; 4 = advanced longitudinal integration. Five domains were assessed: (a) biotechnology and genetics; (b) digital health and informatics; (c) AI and bioinformatics; (d) AI and technology ethics; and (e) overall integration. Two reviewers independently coded a randomly selected subset of 20 entries (15.3% of the total) to assess procedural consistency; disagreements were resolved by discussion and consensus. Because formal inter-coder reliability statistics were not calculated for the full matrix in the original dataset, domain scores are treated as descriptive documentary signals rather than validated prevalence estimates.

Denominators and missing data
Three analytic denominators are distinguished: (a) total entries (n=131); (b) codifiable entries with sufficient documentation (n=92); and (c) non-codifiable entries (NC; n=39), interpreted as documentation gaps, not evidence of curricular absence.
Country stratification
Brazil was interpreted separately because its 89 codifiable entries were coded using national curricular guidelines rather than institution-specific pedagogical projects, limiting direct comparability with other countries.
Use of contextual literature
Selected international consensus frameworks, recent systematic or scoping reviews, Delphi studies, and authoritative WHO and UNESCO guidance already cited in this manuscript were used narratively to contextualize the audit findings and organize discussion of possible educational responses. These sources were not assembled through an exhaustive database-search protocol and were not screened or counted as a review evidence set. Accordingly, the competency areas and curricular map presented in the Discussion should be interpreted as evidence-informed proposals for regional deliberation rather than as products of a systematic evidence synthesis or validated consensus process.

III. Results

Curriculum audit
The matrix contained 131 public medical-school entries: 89 from Brazil, 22 from Argentina, 10 from Bolivia, 9 from Paraguay, and 1 from Uruguay. Of these, 92 were codifiable and 39 were non-codifiable because publicly accessible documentation was insufficient (Table 1). Figure 1 summarizes the curriculum-audit flow and analytic denominators.

Table 1. Country-stratified documentation status in the public medical-school matrix.

Country	Total entries	Codifiable	Non-codifiable	Main interpretation
Argentina	22	1	21	One institutional curriculum: partial AI-adjacent bioinformatics; most entries: documentation gaps.
Brazil	89	89	0	Coded via national DCN 2014; regulatory signal, not evidence of local implementation.
Bolivia	10	1	9	One codifiable institutional curriculum; most entries: documentation gaps.
Paraguay	9	1	8	One explicit medical informatics entry; AI absent.
Uruguay	1	0	1	Public entry not codifiable in matrix.
Total	131	92	39	Broad universe coverage; uneven at codifiable-document level.

Among codifiable entries, AI/bioinformatics was absent in 91 of 92 entries (98.9%), with only one partial AI-adjacent signal. AI/technology ethics did not reach partial integration in any entry: all 92 codifiable entries scored 1 (tangential general bioethics only). Digital health/informatics showed partial integration more frequently, but this was strongly influenced by Brazil's national framework. Table 2 presents the complete domain score distribution.

Table 2. Distribution of domain scores among codifiable entries (n=92).

Domain	Score 0	Score 1	Score 2	Score 3	Score 4
Biotechnology/genetics	0 (0.0%)	0 (0.0%)	89 (96.7%)	3 (3.3%)	0 (0.0%)
Digital health/informatics	2 (2.2%)	0 (0.0%)	89 (96.7%)	1 (1.1%)	0 (0.0%)
AI/bioinformatics	91 (98.9%)	0 (0.0%)	1 (1.1%)	0 (0.0%)	0 (0.0%)
AI/technology ethics	0 (0.0%)	92 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Overall integration	0 (0.0%)	0 (0.0%)	91 (98.9%)	1 (1.1%)	0 (0.0%)

Scores: 0 = absent; 1 = tangential; 2 = partial; 3 = explicit; 4 = advanced integration.

Figure 1. Curriculum audit flow and analytic denominators.

CURRICULUM AUDIT FLOW
Public medical-school entries identified: 131 Argentina: 22 | Brazil: 89 | Bolivia: 10 | Paraguay: 9 | Uruguay: 1 Non-codifiable entries (insufficient public documentation): 39 Codifiable entries included in analysis: 92

IV. Discussion

To our knowledge, this is the first cross-national curriculum audit focused specifically on documented AI-related content in public medical schools across the expanded MERCOSUR region. Its principal contribution is empirical: among codifiable entries, explicit AI/bioinformatics content was nearly absent, while AI-specific ethics did not progress beyond tangential general bioethics. The literature cited in this section is used to interpret the significance of those documentary gaps and to support educational implications rather than as a separately synthesized evidence set.

The curricular findings are striking in their consistency. AI/bioinformatics was absent in 98.9% of codifiable entries, and AI-specific ethics did not exceed tangential general bioethics in any codifiable entry. This pattern is directionally consistent with a Spanish curriculum audit reporting absent AI-related content in 69.2% of medical schools [33], and it complements recent Latin American mapping and commentary describing uneven and still-emerging AI integration in medical education [34,38]. A Korean national process similarly used documented educational need as a basis for subsequent consensus development [37]. However, the MERCOSUR percentages should be interpreted as documentary signals rather than direct prevalence estimates of classroom practice, particularly because Brazilian entries were represented by national guidance rather than institution-specific pedagogical projects.

International literature provides a useful benchmark for interpreting these gaps. The DECODE framework emphasizes digital professionalism, health information systems, health data science, AI, and precision medicine [4]. Reviews of AI and digital-health education identify recurring needs in AI fundamentals, data management, critical appraisal, ethics, communication, teamwork, and implementation [5-7,24,25,27,32,35]. Delphi and consensus studies from Türkiye, South Korea, and China further support competency-based approaches that extend beyond technical knowledge to appraisal, professionalism, and clinical use [36,37,39]. WHO and UNESCO guidance reinforces transparency, accountability, human oversight, equity, and AI literacy as core considerations [21,22,40,41]. These sources are presented as contextual support, not as an exhaustive literature synthesis. Needs-assessment research also documents demand for formal AI education among medical learners and educators [26].

Table 3. Selected international frameworks and literature used to contextualize the curriculum audit and proposed competency areas.

Source / framework	Key contribution	Framework domains supported
Car et al. JAMA Netw Open. 2025 [4]	DECODE digital health competencies consensus (international Delphi, 22 countries)	C1, C2, C3
Hunt et al. npj Digit Med. 2026 [32]	Scoping review; 54 studies, 22 countries; 7 domains, 37 competencies, 170 learning objectives	C1, C3, C4
WHO AI ethics guidance 2021 + 2023 [21,22]	Human rights, transparency, equity, governance, safety	C4
Charow et al. JMIR Med Educ. 2021 [5]	AI education for health professionals: scoping review	C1–C5 (structure)
Gazquez-Garcia et al. JMIR Med Educ. 2025 [6]	Systematic review of key AI skills for health professionals	C1–C5 (structure)
Çalışkan et al. PLoS One. 2022 [36]	e-Delphi study: 23 AI competencies, medical education curriculum	C1, C3, C4
Lee et al. Acad Med. 2024 [37]	Korean national Delphi + student survey on AI competencies	C1, C3, C5
Hernández Rincón et al. BMC Med Educ. 2025 [34]	AI in medical education in Latin America; regional curricular mapping and implementation context	Latin America context
Gordon et al. Med Teach. 2024 [35]	BEME Guide No. 84 scoping review; AI in medical education	C1–C3

Source / framework	Key contribution	Framework domains supported
DECIDE-AI (Vasey et al.) Nat Med. 2022 [23]	Early-stage clinical AI evaluation; decision support reporting	C3
Equity/bias literature [12,13,16]	Algorithmic bias; underdiagnosis in underserved populations	C4
Longhini et al. J Med Internet Res. 2022 [24]	Digital health competencies systematic review	C2
Garvey et al. JMIR Med Inform. 2022 [25]	AI implementation competencies: scoping review	C3
UNESCO AI in education guidance [40,41]	Human rights, equity, AI literacy, and responsible use in education systems	C4, C5

Implications for a minimum regional competency standard

Against this background, the curriculum audit supports discussion of five priority competency areas for undergraduate medical education: (C1) AI and data literacy for clinical reasoning; (C2) health-data governance and digital systems; (C3) critical appraisal and clinical validation of AI tools; (C4) ethics, equity, and accountability in AI; and (C5) human-centered AI use, communication, and teamwork. These areas are not presented as a validated consensus standard. They are an evidence-informed proposal designed for subsequent regional Delphi testing, with emphasis on four pragmatic properties: relevance to all graduates, feasibility in resource-constrained curricula, assessability through observable performance, and alignment with patient safety and health equity.

Table 4. Proposed minimum AI competency-and-assessment framework for discussion and regional validation.

Competency	Minimum SMART outcome	Assessment evidence	Min. performance	Adv. performance
C1. AI and data literacy for clinical reasoning	By graduation, explain (clinical vignette) what an AI output means, what data it was trained on, and ≥2 limits (uncertainty, overfitting, poor external validity).	MCQs/SAQs; model output interpretation; oral defense.	Distinguishes correlation from causation; identifies uncertainty.	Explains how training data and validation design affect local applicability.
C2. Health-data governance and digital systems	By graduation, identify how EHR data quality, privacy, interoperability, and documentation affect AI performance and patient safety.	EHR OSCE; data-quality audit; portfolio.	Identifies data-quality and privacy risks; proposes one safe action.	Designs basic governance checklist for local clinical AI use case.
C3. Critical appraisal and clinical validation of AI tools	By graduation, appraise an AI clinical study and determine whether the tool is sufficiently validated for a specified patient population and workflow.	Critical appraisal assignment; journal club rubric; simulated adoption committee.	Identifies absence of external validation, subgroup analysis, calibration, or workflow evidence.	Justifies adoption, rejection, or pilot testing with safety and equity criteria.
C4. Ethics, equity, and accountability in AI	By graduation, analyze a case involving AI and identify privacy, bias, transparency, liability, human oversight, and equity issues.	Case-based OSCE; ethics memo; structured debate.	Identifies stakeholders, ethical risks, and mitigation steps.	Balances autonomy, justice, accountability, and local inequities in defensible action plan.
C5. Human-centered AI use, communication, and teamwork	By graduation, explain an AI-supported recommendation to a patient in understandable language while preserving shared decision-making and clinical responsibility.	Patient-communication OSCE; supervised AI-use log; interprofessional project.	Explains AI as supportive, not definitive; obtains consent when relevant.	Collaborates with data/informatics teams; communicates uncertainty transparently.

The distinction between C1 and C3 is particularly important. A student may understand what an AI output means yet remain unable to judge whether an algorithm has adequate external validation, subgroup performance, calibration, or workflow evidence for local use. This distinction is consistent with contemporary competency frameworks and reviews [4,6,23,32,35] and is especially relevant when tools developed in high-income tertiary settings are considered for rural or resource-limited health systems. DECIDE-AI provides useful methodological language for discussing early clinical evaluation, workflow, monitoring, and safety [23].

The proposed framework deliberately avoids requiring advanced programming, model development, or high-end digital infrastructure. In resource-constrained settings, clinically meaningful AI competence may instead involve recognizing poor local validation, identifying bias or data-quality problems, protecting privacy, communicating uncertainty, and understanding when a digital tool may widen rather than reduce inequity [12,13,16,21,22]. In this sense, AI competence can be framed as a patient-safety and health-equity competency rather than as a technology elective. UNESCO guidance similarly places responsible AI use, human rights, and equity at the center of educational implementation [40,41].

Table 5. Illustrative six-year curricular integration map for the proposed minimum competency areas.

Year	Curricular space	Competency focus	Learning emphasis	Min. assessment evidence
1	Biostatistics; Ethics	C1, C4	AI as probabilistic support; uncertainty, privacy, accountability, introductory technology ethics.	MCQs on uncertainty; short ethics vignette.
2	Epidemiology; Public Health	C1 reinforce; C3, C2 introduce	Validity, bias, population data, data quality, health information systems, digital inequity.	Critical appraisal worksheet; governance checklist.
3	Clinical rotations; electives	C5 primary; C2, C3 via electives	Patient-centered explanation of AI-supported information; appraisal of diagnostic tools in early clinical settings.	OSCE explaining AI-supported recommendation; elective appraisal.
4	Clinical rotations; discipline electives	C5 primary; C2, C3 via electives	Workflow integration, documentation quality, model limitations in specialty contexts, interprofessional collaboration.	Simulated adoption committee; portfolio entry.
5	Advanced clinical rotations; electives	C5 primary; C2, C3 via electives	Uncertainty communication, equity risks, subgroup performance, digital determinants of health.	OSCE with consent and uncertainty; equity-focused appraisal.
6	Internship/clerkship; supervised project	C5 primary; integration C2, C3	AI literacy, governance, validation, ethics, and patient-centered use in real or simulated clinical practice.	Quality-improvement project; portfolio defense; final OSCE (C1–C5).

The curricular integration map in Table 5 embeds these areas within existing courses - including biostatistics, epidemiology, public health, bioethics, clinical reasoning, and clerkships - rather than requiring five standalone courses. This approach is consistent with literature supporting longitudinal integration of digital and AI competencies into existing educational structures [27,29,30]. The next step should be regional validation through a structured Delphi process with representation from all five countries, followed by pilot implementation in institutions with differing resource profiles. Such validation should test relevance, feasibility, assessment burden, student performance, faculty readiness, and equity implications before any accreditation use.

V. Limitations

Curriculum audit. The study relied on a secondary matrix without formal inter-coder reliability statistics for the full dataset. Non-codifiable entries (n=39) represent documentation gaps, not proven curricular absence. Brazilian entries were coded through national curricular guidance rather than institution-specific pedagogical projects, limiting direct cross-country comparability. Public documentation may also fail to capture electives, seminars, faculty initiatives, or clinical experiences delivered outside formal published curricula.

Contextual literature. The literature used in the Background and Discussion was selected purposively to interpret the curriculum audit and support the proposed educational implications. It was not searched or screened as a systematic or scoping review and should not be interpreted as an exhaustive evidence synthesis. Relevant studies, national guidance, or non-English-language sources may therefore have been omitted.

Proposed framework. The five competency areas and curricular integration map are interpretive proposals derived from the audit findings and contextual international literature. They have not undergone MERCOSUR-wide Delphi consensus, pilot implementation, or psychometric evaluation of the proposed assessment approaches and should not be adopted as a regulatory or accreditation standard until these validation steps are completed.

Conclusions

The expanded MERCOSUR region shows a substantial documentary gap in explicit AI-related undergraduate medical education. Among 92 codifiable public medical-school entries, AI/bioinformatics was absent in 91 (98.9%), and AI/technology ethics did not progress beyond tangential general bioethics. These findings provide a clear empirical rationale for regional curricular development while also highlighting important documentation and comparability limitations. Drawing on established international frameworks and guidance only as contextual support, we propose five priority areas for subsequent regional deliberation: AI and data literacy; health-data governance and digital systems; critical appraisal and clinical validation; ethics, equity, and accountability; and human-centered AI use, communication, and teamwork. The audit does not establish a validated regional standard; Delphi consensus and pilot implementation are the necessary next steps.

Declarations

Ethics approval and consent to participate

Not applicable. This study used publicly available institutional and national regulatory curricular documents. It did not involve human subjects, patient data, animal subjects, or identifiable personal information.

Consent for publication

Not applicable.

Availability of data and materials

The secondary curricular matrix is available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interests.

Funding

No external funding was received for this work.

Authors' contributions

Raul Desvars: conceptualisation, curriculum audit design, interpretation, manuscript writing (original draft), and development of the proposed competency implications. Elena Schupp: contextual literature review, interpretation, and critical revision. Jorge Rojas: competency-framework conceptualisation, curricular integration map, and critical revision. Gabriela Fernandez: curricular integration map and critical revision. Javier Cubas: critical revision and final revision. All authors approved the final manuscript.

Declaration of AI tool use

During preparation of this manuscript, generative AI tools assisted with manuscript organisation, bibliographic formatting, and linguistic editing. All outputs were reviewed by the authors. Artificial intelligence was not used to collect or code curricular documents, determine domain scores, or substitute authorial interpretation. The literature used for contextual discussion and the educational implications were selected and interpreted by the authors, who assume full intellectual responsibility for the content, consistent with ICMJE recommendations.

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