

DocIAComp: Development and validation of a teacher competency framework for the pedagogical use of artificial intelligence

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Abstract. *This article presents the development and validation of DocIAComp, a teacher competency framework for the pedagogical use of artificial intelligence. The framework was developed through a qualitative, sequential process involving a review of international, regional, and institutional guidelines, empirical validation with teacher-students at Universidad Tecnológica in Uruguay, and the triangulation of theoretical and empirical findings. The final proposal comprises eight competency areas and twenty-one competencies, each defined through descriptors, knowledge, skills, and attitudes. Results reveal that participants highly valued all competencies but reported gaps between their perceived importance and their own level of proficiency. These findings highlight the need for systematic teacher education in AI and support the use of DocIAComp to guide training, institutional policies, and future research.*

Keywords— *Artificial intelligence, teacher competencies, higher education, teacher education, competency framework.*

Resumo. *Este artigo apresenta o desenvolvimento e a validação do DocIAComp, um marco de competências docentes para o uso pedagógico da inteligência artificial. O referencial foi desenvolvido por meio de um processo qualitativo e sequencial, que envolveu a revisão de diretrizes internacionais, regionais e institucionais, a validação empírica com docentes em formação da Universidad Tecnológica, no Uruguai, e a triangulação dos resultados teóricos e empíricos. A proposta final compreende oito áreas de competência e vinte e uma competências, cada uma definida por descritores, conhecimentos,*

habilidades e atitudes. Os resultados mostram que os participantes atribuíram grande importância a todas as competências, mas relataram lacunas entre essa importância e seu próprio nível de proficiência. Esses achados evidenciam a necessidade de uma formação docente sistemática em IA e sustentam o uso do DocIAComp para orientar processos formativos, políticas institucionais e pesquisas futuras.

Palavras-chave— *Inteligência artificial; competências docentes; educação superior; formação docente; marco de competências.*

1 Introduction

The rapid advancement of artificial intelligence across social, economic, and cultural domains presents new challenges for educational systems and, more specifically, for teacher education and professional development. In higher education, the expansion of generative AI tools has highlighted both their potential to support teaching, assessment, and the production of educational resources, as well as the risks associated with their critical and ethical use [Miao and Holmes 2023, UNESCO 2024].

At the national level, Uruguay has taken significant regulatory and strategic steps. Article 74 of Law No. 20,212 assigns the Agency for Electronic Government and the Information and Knowledge Society (AGESIC) the responsibility for designing and developing a national data and artificial intelligence strategy, based on international standards and applicable to both the public and private sectors. This legal basis is complemented by AGESIC's work on digital strategies and by initiatives such as the Observatory on the Use of AI in the State, aimed at promoting the ethical, responsible, safe, and trustworthy use of this technology. Taken together, these developments show that the country is no longer merely in an exploratory phase, but rather in a progressive process of institutionalizing AI governance.

In this context, higher education must also move in this direction. In Uruguay, institutional guidelines, debates, and initiatives already exist. However, a gap remains between these general orientations and their translation into concrete competencies that include knowledge, skills, and attitudes for teaching practice. In this sense, there is a clear need for a specific competency framework capable of defining what teachers should know, know how to do, and value in order to integrate AI in a pedagogically meaningful, critical, and responsible way.

The international literature has advanced in the conceptualization of teacher competencies related to AI. In 2024, UNESCO published the AI Competency Framework for Teachers, which proposes a global perspective for defining and developing competencies aimed at the ethical and effective use of AI in teaching, learning, and assessment. At the same time, even if not specific to the use of AI, DigCompEdu remains one of the most influential frameworks for understanding teachers' digital competence [Redecker and Punie 2017], which can be taken as a basis for developing other similar frameworks. More recently, the Chilean Ministry of Education updated its Guiding

Framework for Teachers' Digital Competencies, explicitly incorporating the challenges of contemporary digital transformation, including AI, into teacher professional development [Ministerio de Educación de Chile 2025].

In this sense, there is a clear need to create a detailed competency framework based on the Uruguayan teachers' needs. Taking this into consideration, the study presented in this article aimed to develop and validate a teacher competency framework for the pedagogical use of artificial intelligence. It was conducted at the Technological University of Uruguay (UTEC) and resulted in the development and validation of DoCIAComp. Its contribution lies in offering a guiding tool for teacher education, curriculum design, and institutional policy.

2. Developing Teacher Competencies for the Pedagogical Use of AI

Contemporary discussion on the use of digital technologies in education has deepened with the expansion of AI. In this regard, UNESCO's guidance on generative AI warns that most countries and institutions were not prepared for the rapid emergence of these tools and that, therefore, immediate actions, long-term policies, and the development of human capacities are required to ensure their responsible use [Miao and Holmes 2023]. This perspective is further elaborated in the UNESCO AI Competency Framework for Teachers (AI-CFT), which proposes principles, knowledge, and concrete skills for integrating AI into teaching, learning, and assessment without displacing human agency [UNESCO 2024].

In addition to this framework, others also provide valuable inputs for thinking about the competencies required in teaching practice in the field of digital technologies and, in particular, AI. In this regard, DigCompEdu [Redecker and Punie 2017] and CompDocHíbrido [Da Rosa Suárez et al. 2025] offer an especially useful architecture for this discussion because they make it possible to conceptualize teacher competence beyond the instrumental use of tools, thereby providing a solid basis for adapting and integrating specific AI-related dimensions. Recent literature thus suggests that AI does not merely require new tools, but rather new professional competencies situated within a broader understanding of teaching work.

The need for specific frameworks is also reinforced by empirical evidence. Higher education teachers recognize opportunities in generative AI, but also express concerns related to quality, ethics, and the redefinition of teaching work [Lee et al. 2024]. Wang et al. [2024], in their analysis of university policies and guidelines, found that an open yet cautious stance predominates, with strong attention to transparency, privacy, academic integrity, and the redesign of assessment. Xia et al. [2024] add that assessment is one of the areas most affected by generative AI and that its transformation requires AI literacy, assessment literacy, and new criteria for the design of evidence of learning.

In this regard, [Del Valle 2025] affirms that AI in education has significant transformative potential, but also entails risks associated with algorithmic bias and the need for ethical and regulatory frameworks. Flores-Vivar and García-Peñalvo [2023], in

turn, emphasize that the educational integration of AI requires simultaneous consideration of its potential, limitations, and ethical challenges in relation to quality education. At the regional level, a recent study on teacher education in Brazil and Uruguay highlights the need to integrate the development of teacher competencies for the use of digital technologies, and AI in particular, into teacher education curricula [Guizzo et al. 2026].

In this sense, UNESCO's AI competency framework is presented as a global reference point rather than a fixed model to be applied across different contexts. As a result, it cannot fully address the specific needs of teachers within any single national context. For this reason, a framework specific to Uruguay was developed in this study. This framework was not simply adapted from UNESCO's guidelines. It was also developed through empirical data collected from a group of teachers who were attending or had completed a postgraduate course in educational technology. This process allowed the resulting framework to reflect the actual professional needs of Uruguayan teachers. The Uruguayan framework is not intended to replace UNESCO's model but rather to localize it, incorporating empirical evidence and contextual detail that a global framework, by design, cannot provide.

Based on this, the methodological procedures used to develop the DocIAComp teacher competency framework for the pedagogical use of artificial intelligence were outlined and are presented in the following section.

3. Methodology

This study adopted a qualitative sequential design with empirical validation, aimed at developing and consolidating a teaching competency framework for the pedagogical use of artificial intelligence in higher education. The methodological process was organized into three complementary stages: (1) conceptual review and preliminary framework design, (2) empirical validation of the preliminary framework, and (3) triangulation and refinement of the final proposal.

3.1. Stage 1: Conceptual review and preliminary framework design

In the first stage, a review of international and regional competency frameworks related to teaching, digital technologies, and artificial intelligence was conducted. This review included the UNESCO AI Competency Framework for Teachers [UNESCO 2024], DigCompEdu [Redecker and Punie 2017], and CompDocHíbrido [Da Rosa Suárez et al. 2025], as well as existing guidelines and policy documents produced by Uruguayan institutions such as the Universidad de la República (UdelaR), the Consejo de Formación en Educación (CFE) of the Administración Nacional de Educación Pública (ANEP), the Universidad Tecnológica del Uruguay (UTEC), and AGESIC [AGESIC 2024] regarding the use of digital technologies and artificial intelligence.

The purpose of this stage was not only to identify existing competency proposals, but also to examine how different frameworks conceptualize the role of teachers

in technology-rich environments and, more specifically, in contexts shaped by the growing presence of AI. Special attention was paid to competency domains, progression logics, ethical principles, and pedagogical dimensions that could be relevant for higher education teaching practice.

Based on this review, a preliminary framework was developed and organized into eight competency areas. At this point, the framework was conceived as an initial analytical structure intended to integrate contributions from international references, regional developments, and the specific needs of the Uruguayan higher education context. This preliminary version served as the conceptual basis for the next stage of the study.

3.2. Stage 2: Empirical validation of the preliminary framework

In the second stage, the preliminary framework was subjected to empirical validation through a questionnaire administered to teachers who were also students and graduates of UTEC's Specialization in Educational Technology. The target population consisted of 96 participants, and the final sample included 57 respondents, representing 59.3% of the total population.

The questionnaire was designed to gather participants' perceptions regarding the proposed competencies. For each competency, two indicators were collected: perceived importance, and self-reported level of development. Both indicators were measured using a five-point Likert scale. This design made it possible to compare the value attributed to each competency with the degree to which participants considered that they had already developed it in their own professional trajectory.

In addition to these scaled items, the instrument included open-ended questions aimed at identifying broader perceptions about the expansion of AI in education. These responses allowed the study to capture not only evaluative judgments about the framework, but also qualitative insights into the pedagogical, ethical, and organizational tensions associated with the incorporation of AI in higher education.

This validation stage was especially relevant because it allowed the framework to be contrasted with the perceptions of a population directly linked to teacher education and educational technology. In this sense, the empirical phase did not seek to statistically generalize findings to all higher education teachers, but rather to test the internal coherence, perceived relevance, and formative usefulness of the proposed framework in a context closely connected to professional development in digital education.

3.3. Stage 3: Triangulation and refinement of the final framework

In the third stage, the findings from the conceptual review and the empirical validation were triangulated in order to refine the framework. This process involved comparing the theoretical assumptions that guided the construction of the preliminary proposal with the evidence gathered through the questionnaire.

The triangulation process made it possible to identify which areas and competencies were strongly supported by the literature and also highly valued by participants, as well as where tensions or gaps appeared between conceptual relevance and perceived

levels of development. On that basis, the preliminary framework was revised by reorganizing some areas, refining competency descriptors, and adjusting the components associated with each competency.

As a result of this stage, the final version of DocIAComp was consolidated as a framework composed of eight competency areas and their corresponding competencies, descriptors, and elements, namely knowledge, skills, and attitudes. The resulting framework was thus shaped by both theoretical grounding and empirical input, which strengthened its consistency and contextual relevance for the Uruguayan higher education setting.

4. Results

The main outcome of this study is the DocIAComp framework of teacher competencies for the pedagogical use of artificial intelligence. Participants expressed a high valuation of the proposed framework and confirmed gaps between the importance attributed to the competencies and their self-reported level across all of them, underscoring the need for systematic AI training. The analysis also revealed substantial perceptions regarding the pedagogical, ethical, and organizational opportunities and tensions that emerge with the incorporation of AI into education.

The resulting framework is structured into eight competency areas, each composed of specific competencies and their elements: knowledge, skills, and attitudes. Table 1 presents a synthesis of the framework, including its areas, competencies, and descriptors.

Table 1. Synthesis of the DocIAComp Framework

Area	Competency	Description
1. Professional Engagement with AI	1.1 Collaboration and Community of Practice in AI	Participation in networks and collaborative spaces to exchange experiences, resources, and criteria regarding the pedagogical use of AI
	1.2 Continuous Professional Development in AI	Ongoing and critical updating on AI in order to strengthen its pedagogical, ethical, and contextualized integration
2. Digital Resources with AI	2.1 AI-Assisted Educational Curation	Search, selection, and adaptation of resources with AI support according to criteria of quality, relevance, and reliability
	2.2 Creation of Resources with AI	Design and production of materials with AI guided by explicit pedagogical purposes
	2.3 Organization of Resources and Environments with AI	Clear and accessible structuring of resources, activities, and digital environments with AI sup-

port.

3. Teaching with AI	3.1 Curriculum Design with AI	Planning proposals, sequences, and activities with AI in alignment with objectives and pedagogical decisions
	3.2 Pedagogical Grounding of AI Integration	Justification of the incorporation of AI on the basis of pedagogical frameworks, evidence, and educational criteria
	3.3 Pedagogical Mediation with AI	Support for learning with AI in order to foster participation, autonomy, and collaboration
4. Assessment with AI	4.1 AI-Assisted Assessment of Learning	Design and implementation of assessments with AI while safeguarding validity, relevance, and teacher review
	4.2 Feedback with AI	Provision of timely feedback with AI, enriched by teachers' pedagogical judgment
5. Management of AI Use	5.1 Organization and Management of Teaching Documentation with AI	Management of lesson plans, records, and evidence with AI in an orderly, efficient, and traceable manner
	5.2 Governance, Compliance, and Selection of AI Tools	Selection and use of AI tools in accordance with pedagogical, regulatory, and institutional criteria
6. Ethics, Rights, and Well-being in AI	6.1 Principles and Rights	Guidance for the use of AI based on ethical principles and human rights in education
	6.2 Equity and Bias Mitigation	Identification and reduction of biases and inequities in data, systems, and AI-mediated practices
	6.3 Privacy, Security, and Digital Well-being	Protection of data, information security, and socio-emotional well-being in contexts of AI use
	6.4 Transparency, Traceability, and Academic Integrity	Documentation and explicit acknowledgment of AI use while safeguarding authorship, academic honesty, and review
7. Research and Improvement with AI	7.1 Research on Practice with AI	Inquiry into and analysis of one's own practice with AI in order to guide teaching improvement
	7.2 Impact and Equity Assessment	Evaluation of the effects of AI on learning, participation, workload, and inequalities
	7.3 Open Science and Transfer	Sharing of resources, findings, and outputs in order to foster reuse, adaptation, and scaling
8. Human Responsi-	8.1 Agency and Responsible	Exercise of professional judgment to decide

bility	Decision-Making Regarding AI	when, how, and for what purposes to use AI in education
	8.2 Human Oversight and Validation of AI	Critical review of AI-generated outputs, while assuming final responsibility for their educational use

The first area, Professional Engagement with AI, includes the competencies Collaboration and Community of Practice in AI and Continuous Professional Development in AI, both centered on continuous updating and collaborative work. The second area, Digital Resources with AI, comprises three competencies: AI-Assisted Educational Curation, Creation of Resources with AI, and Organization of Resources and Environments with AI.

The third area, Teaching with AI, integrates Curriculum Design with AI, Pedagogical Grounding of AI Integration, and Pedagogical Mediation with AI. The fourth area, Assessment with AI, includes AI-Assisted Assessment of Learning and Feedback with AI, emphasizing the role of teacher judgment in AI-supported assessment and in the provision of feedback. The fifth area, Management of AI Use, comprises Organization and Management of Teaching Documentation with AI and Governance, Compliance, and Selection of AI Tools.

The sixth area, Ethics, Rights, and Well-being in AI, brings together four competencies: Principles and Rights, Equity and Bias Mitigation, Privacy, Security, and Digital Well-being, and Transparency, Traceability, and Academic Integrity, all of which were strongly highlighted by participants as indispensable in AI-mediated education. The seventh area, Research and Improvement with AI, includes Research on Practice with AI, Impact and Equity Assessment, and Open Science and Transfer.

Finally, the eighth area, Human Responsibility, includes Agency and Responsible Decision-Making Regarding AI and Human Oversight and Validation of AI, underscoring the irreplaceable role of human judgment, prudence, and teacher responsibility in deciding when, how, and whether the use of AI is appropriate in educational settings.

Taken together, these findings consolidate DocIAComp as a robust and contextualized framework for the Uruguayan context, capable of guiding teacher education policies, strengthening institutional culture, and supporting teacher professional development toward a critical, ethical, and pedagogically meaningful use of artificial intelligence.

5. Conclusion

The main contribution of DocIAComp is that it translates broad AI guidelines into a concrete competency architecture for teaching. While many discussions about AI in education remain at the level of policy, regulation, or general ethical debate, this framework moves toward a more operational question: what teachers need to know, know how to do, and value to integrate AI in pedagogically meaningful ways.

A second contribution lies in its contextualization. DocIAComp does not mechanically replicate international frameworks, but rather adapts them to a specific national and institutional ecosystem. In this sense, the articulation among UNESCO, DigCompEdu, regional precedents, and national guidelines strengthens the relevance of the proposal.

A third contribution is that it proposes a perspective of sustainable AI integration in higher education. Here, sustainability is understood not only in terms of technological adoption, but as the capacity to innovate without undermining pedagogical quality, equity, transparency, or professional autonomy. The gap identified between the high importance attributed to the competencies and the lower self-reported level of mastery indicates precisely that AI integration cannot rely solely on access to tools: it requires systematic training, institutional policies, and teacher support. This finding is consistent with recent literature showing that teachers perceive the potential of generative AI, but also demand guidance frameworks and specific professional development.

Among the study's limitations, it should be noted that validation was carried out with a specific population linked to a postgraduate program in Educational Technology, and that the data are self-reported. However, these limitations do not invalidate the contribution of the study; rather, they define its scope and open a future agenda for research: evaluating the implementation of the framework, adapting it to other institutions and educational levels, and exploring its use as a basis for teacher education and teacher self-assessment mechanisms.

In sum, DocIAComp offers a structured, contextualized, and conceptually robust framework for guiding both teacher education processes and institutional decision-making. Rather than promoting an instrumental use of AI, it proposes a teacher profile grounded in pedagogical judgment, ethical responsibility, critical reflection, and human agency. In a context of rapid expansion of generative AI, this orientation is essential for truly meaningful pedagogical integration.

References

- AGESIC (2024). Agencia de Gobierno Electrónico y Sociedad de la Información y del Conocimiento. *Observatorio de uso de inteligencia artificial en el Estado*. Mirador de Gobierno Abierto. Recuperado el 28 de abril de 2026, de <https://miradordegobiernoabierto.agesic.gub.uy/SigesVisualizador/gu/o/GA/p/2264>
- Da Rosa Suárez, G. G., Behar, P. A. and da Silva, K. K. A. (2025). Pedagogical model for teacher training courses: Developing teaching competencies for hybrid modality. En A. B. Lliteras, A. S. Sprock, & V. Agredo-Delgado (Eds.), *Proceedings of the 19th Latin American Conference on Learning Technologies (LACLO 2024)* (pp. 271–286). Springer. https://doi.org/10.1007/978-981-96-3698-3_20
- Del Valle, E. (2025). La inteligencia artificial en la educación: Potencial transformador, riesgos de sesgo y desafíos éticos. *Revista Iberoamericana de Educación*, 99(1), 79–93. <https://doi.org/10.35362/rie9916838>

- Flores-Vivar, J. M. and García-Peñalvo, F. J. (2023). Reflexiones sobre la ética, potencialidades y retos de la inteligencia artificial en el marco de la educación de calidad (ODS4). *Comunicar*, 31(74), 37–47. <https://doi.org/10.3916/C74-2023-03>
- Guizzo, M. A. R., Lorandi, A., da Rosa Suárez, G. G. and Behar, P. A. (2026). Formación docente en Brasil y en Uruguay: Directrices para la integración de tecnologías digitales en los planes de estudios. *Actualidades Investigativas en Educación*, 26(1), 1–24. <https://doi.org/10.15517/zpqjr857>
- Lee, D., Arnold, M., Srivastava, A., Plastow, K., Strelan, P., Ploeckl, F., Lekkas, D. and Palmer, E. (2024). The impact of generative AI on higher education learning and teaching: A study of educators' perspectives. *Computers and Education: Artificial Intelligence*, 6, Article 100221. <https://doi.org/10.1016/j.caeai.2024.100221>
- Miao, F. and Holmes, W. (2024). *Guía para el uso de IA generativa en educación e investigación*. UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000389227>
- Ministerio de Educación de Chile. (2025). *Marco orientador de competencias digitales docentes*. https://ciudadaniadigital.mineduc.cl/wp-content/uploads/2025/06/Marco-Orientador-de-Competencias-Digitales-Docentes-V012026_1.pdf
- Redecker, C. and Punie, Y. (2017). *European framework for the digital competence of educators: DigCompEdu* (Y. Punie, Ed.). Publications Office of the European Union. <https://doi.org/10.2760/159770>
- UNESCO. (2024). *Marco de competencias para docentes en materia de inteligencia artificial*. https://unesdoc.unesco.org/ark:/48223/pf0000393813_spa
- Wang, H., Dang, A., Wu, Z. and Mac, S. (2024). Generative AI in higher education: Seeing ChatGPT through universities' policies, resources, and guidelines. *Computers and Education: Artificial Intelligence*, 7, Article 100326. <https://doi.org/10.1016/j.caeai.2024.100326>
- Xia, Q., Weng, X., Ouyang, F. Q., Lin, T.J. and Chiu, T.K. (2024). A scoping review on how generative artificial intelligence transforms assessment in higher education. *International Journal of Educational Technology in Higher Education*, 21 (1), p. 40. <https://doi.org/10.1186/s41239-024-00468-z>