Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno 6 n. 1 (2026)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Intelligent learning environments and cognitive adaptivity: a neuropedagogical perspective on inclusive education

Sara Pellegrini [1], Anna Borrasi [2] and Filippo Gomez Paloma[3,] *

[1] Link Campus University; s.pellegrini@link.it
[2] Enna Kore University; Anna Borrasi 2; profssaannaborrasi@gmail.com
[3] Università di Cassino e del Lazio Meridionale; filippo.gomezpaloma@unicas.it
* Correspondence: s.pellegrini@link.it

Abstract: This study investigates how intelligent learning environments, conceived as integrated spatial, sensory, technological, and relational configurations, are perceived by education professionals as supporting cognitive adaptability and learning processes in students with Special Educational Needs, within a neuropedagogical and inclusive framework. The sample consists of 107 education professionals, recruited through intentional voluntary sampling, including teachers, educators, and psycho-pedagogical practitioners, with heterogeneous roles, experience, and training backgrounds. A descriptive–exploratory cross-sectional design was adopted. Data was collected via a structured online questionnaire and analyzed using descriptive statistics and cross-tabulations, privileging an interpretative reading of professional representations and emerging pedagogical patterns.

Keywords: Intelligent Learning Environments; Neuropedagogy; Special Educational Needs

1. Introduction

The progressive environmentalization of artificial intelligence (Rosmansyah et al., 2023) in educational contexts and instructional technologies is reshaping learning environments, calling for a critical reconsideration of traditional teaching models and of the epistemological assumptions that have historically sustained them (Pastena, 2020). In increasingly heterogeneous educational scenarios, characterized by diverse cognitive profiles and the structural presence of Special Educational Needs (SEN), the environment can no longer be regarded as a neutral backdrop, but rather as an active pedagogical device (Eugeni, 2021) capable of orienting and sustaining learning processes (Dipace, 2019; Di Tore et al., 2021).

Pedagogical and neuroscientific literature converges in conceptualizing learning as a pluriprocessual cognitive phenomenon (Ferrantino & Tiso, 2025)., in which attentional, perceptual, bodily, emotional and relational dimensions interact in non-linear ways. From this perspective, adaptability cannot be reduced to an individual learner's property but must be understood as an emergent characteristic of the educational system, arising from the dynamic interplay between subjects, environments, and mediating tools within situated learning processes. When embedded within intentional educational design, artificial intelligence can enhance the flexibility and re-

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

sponsiveness of these ecosystems, supporting personalization, differentiation, and formative feedback (Ferrantino & Tiso, 2025; Buccini & Marone, 2025).

At the same time, the integration of intelligent technologies raises critical concerns. Several studies warn against a technicist reduction of learning, in which cognitive complexity is translated into measurable performance or algorithmic adaptation (Selwyn, 2022). The implicit assimilation of human intelligence to computational capacity risks reinforcing disembodied conceptions of cognition, marginalizing bodily experience and pedagogical mediation (Ferrantino & Tiso, 2025; Di Domenico et al., 2025). These tensions call for a critical redefinition of intelligence in educational terms (Poornesh, 2024).

Within this framework, the neuropedagogical perspective offers an integrative lens connecting neural plasticity, cognitive adaptability and embodied experience. Research on embodied cognition highlights learning as emerging from continuous interactions between body, mind, and environment, overcoming dichotomies between real and virtual, natural and artificial (Natalini, 2023; Baldassarre et al., 2025). Intelligent learning environments, physical, digital, or hybrid, can thus amplify attention, motivation, participation and self-regulation, particularly for neurodivergent learners (Perciavalle, 2025; Mangione & De Santis, 2024), provided they are grounded in conscious pedagogical design (Rega et al., 2024; Mirra et al., 2025) and guided by ethical governance (Floridi, 2024). In this sense, human-centered and algoretic approaches frame AI as a tool for support rather than substitution, fostering hybrid forms of intelligence based on cooperation between human agency and artificial systems (Perla et al., 2024; Creati & Cuccaro, 2025).

2. Methods

In light of the theoretical framework outlined and the critical issues emerging in the contemporary debate on the use of artificial intelligence in education, this study is guided by a central research question: how are intelligent learning environments, understood as integrated configurations of spatial, sensory, technological, and relational dimensions, perceived by education professionals as factors capable of supporting cognitive adaptability and learning processes in students with SEN, within a neuropedagogical and inclusive perspective.

The sample consists of 107 education professionals, recruited on a voluntary basis through intentional sampling, including early childhood, primary and secondary school teachers, educators and psycho-pedagogical practitioners. The sample is markedly heterogeneous in terms of professional roles, educational background, and years of experience, reflecting the plurality of contemporary educational contexts. A substantial proportion of participants reported direct experience in special needs education, providing an informed perspective on inclusive processes and educational practices related to SEN.

From a socio-demographic standpoint, most respondents identified as female (70.09%), followed by male participants (25.23%), while a residual proportion (4.67%) chose not to disclose gender. Participants' ages ranged from 23 to 51 years, with a prevalence of individuals in early and middle adulthood, a professionally significant phase characterized by the consolidation of teaching practices and openness to pedagogical innovation. Regarding professional experience, the sample appears

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

balanced: 46.60% reported direct experience in school settings, while 53.40% operated in related educational and training contexts, including educational services, extracurricular learning environments and support or coordination roles. In terms of professional profile, upper secondary school teachers represent the most frequent category, followed by educational, training, and coordination professionals. This articulation supports a multi-perspective reading of the professional representations under investigation.

Building on the central research question, the study investigates not merely the presence of perceived effects, but primarily the pedagogical quality of the relationships between environment, cognition and educational practices, conceptualizing cognitive adaptability as a complex and situated phenomenon. Specifically, the research aims to: (1) analyze professional representations concerning the role of learning environments in attention, motivation, participation, and emotional regulation processes; (2) identify environmental factors considered most relevant for supporting neural plasticity and cognitive adaptability, including multisensory stimulation, spatial organization, movement, peer interaction, and educational technologies; (3) explore the coherence between declared teaching practices and neuropedagogical principles; (4) examine the role attributed to digital technologies as mediators of educational experience; and (5) identify perceived training needs related to learning environment design and the inclusive use of artificial intelligence.

The study adopts a descriptive–exploratory cross-sectional design. Descriptive analysis is conceived as an epistemologically grounded choice aimed at exploring professional representations, privileging an interpretative reading of quantitative data. Data were collected through a structured online questionnaire (34 items), developed ad hoc on the basis of neuropedagogical and inclusive education frameworks and ad-ministered anonymously. Analysis relied on descriptive statistics and cross-tabulations to identify recurring patterns and emerging tensions, interpreted through neuropedagogical models and inclusive education principles.

3. Results

This section presents the results of the investigation in relation to the research question aimed at understanding how intelligent learning environments are perceived by education professionals as factors capable of supporting cognitive adaptability and learning processes in students with SEN. Data are presented in coherence with the study objectives, highlighting the role of the learning environment, neuropedagogical strategies, educational technologies, and teacher training.

Overall, the findings show a strong convergence of professional perceptions regarding the central role of the learning environment in the cognitive development of students with SEN. At the same time, a closer examination of percentage distributions reveals ambivalence: a non-negligible proportion of respondents, while acknowledging the importance of the environment, qualifies its impact as partial, suggesting a tension between theoretical adherence to inclusive models and the perception of real operational constraints. This gap indicates that learning environments are sometimes conceived as potential rather than fully active factors, especially in contexts characterized by organizational limitations and limited resources. Nevertheless, 89.5% of participants attribute a decisive role to the school environment, con-

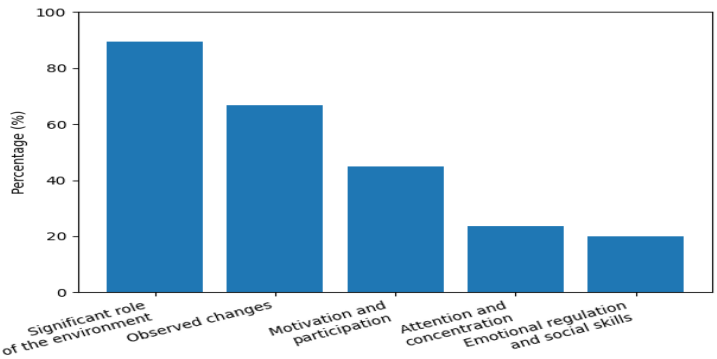
EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

firming its function as an active pedagogical mediator rather than a passive setting. This perception appears consistent across school levels, professional roles, and years of experience, supporting a shared view of learning as a situated and context-dependent process.

Objective 1 – Professional representations of learning environments.

A very high convergence emerges regarding the role of the school environment in supporting cognitive development in students with SEN. Specifically, 89.52% of respondents identify the environment as having a significant impact. Responses to subsequent items indicate strong associations between learning environments and attention, motivation, and active participation. In particular, 66.67% of professionals report observing meaningful changes following targeted environmental or instructional interventions, including increased motivation and participation (45%), improved attention and concentration (23.75%), and gains in emotional regulation and social skills. Overall, these data indicate a widespread professional perception of the learning environment as an active pedagogical device influencing cognitive, emotional, and relational dimensions of learning. (Figure 1).

Figure 1. Professional representations of the role of learning environments in the cognitive development of students with SEN.



Comparative descriptive analyses (cross-tabulations) by professional role and experience in special education do not reveal statistically marked differences but highlight differentiated interpretative orientations. Professionals with direct experience in inclusive contexts emphasize relational and multisensory dimensions, whereas those working mainly in mainstream settings tend to stress organizational and structural aspects.

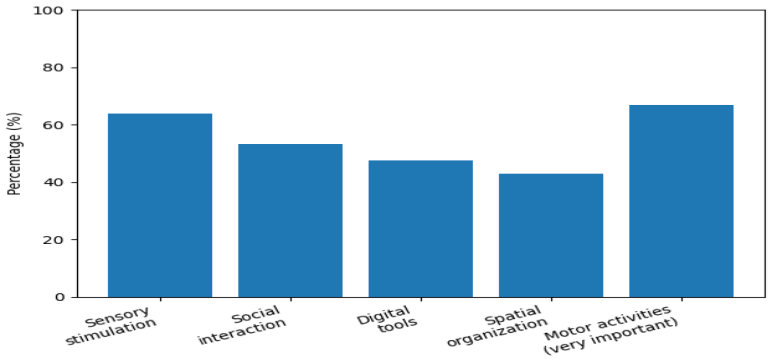
Objective 2 – Environmental factors and cognitive adaptability.

Responses reveal a multidimensional configuration of perceived factors influencing neural plasticity. Sensory stimulation is the most frequently cited factor (63.81%), followed by social interaction (53.33%), digital tools (47.62%), and spatial organization (42.86%). When asked to identify a single priority factor, sensory

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

stimulation remains dominant (38%), followed by social relationships (28%) and bodily–motor activities (15%). Furthermore, 67% of respondents consider the systematic integration of movement to be very important. These findings reflect a conception of cognitive adaptability grounded in embodied, multisensory, and relational experiences (Figure 2).

Figure 2. Professional representations of the role of learning environments in the cognitive development of students with SEN.



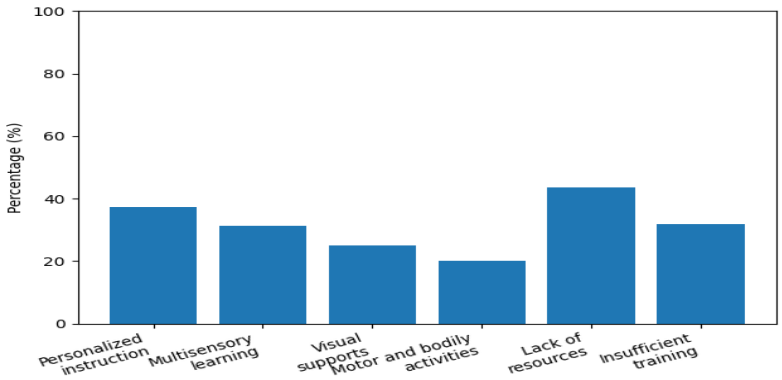
Cross-tabulations indicate that professionals with experience in special education prioritize multisensory stimulation, movement, and social interaction, while other subgroups attribute greater relevance to technologies and spatial organization.

Objective 3 – Coherence between practices and neuropedagogical principles.

Declared teaching strategies show a good level of coherence with embodied and situated neuropedagogical principles. Personalized instruction (37.25%) and multisensory learning (31.37%) are the most frequently adopted practices, followed by visual–tactile supports and bodily activities. Notably, 98% of respondents rate neuropedagogical approaches as very or fairly effective. However, implementation is constrained by insufficient resources (43.62%) and limited specific training (31.91%), indicating a gap between theoretical alignment and operational feasibility (Figure 3).

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

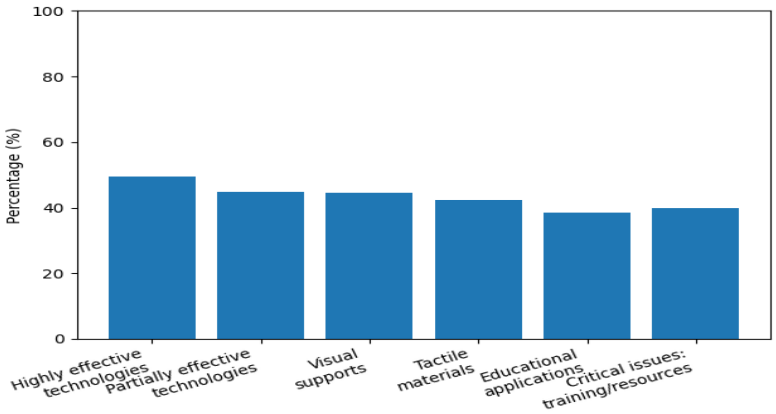
Figure 3. Professional representations of the role of learning environments in the cognitive development of students with SEN.



Objective 4 – Role of educational technologies.

Educational technologies are evaluated positively overall: 49.52% of professionals believe digital tools strongly support cognitive development in students with SEN, while 44.76% report partial effectiveness. Technologies are perceived mainly as mediators of educational experience rather than as ancillary tools. Frequently cited resources include tactile materials (42.42%), visual supports (44.44%), and educational applications (38.38%), confirming an integrated digital–embodied approach (Figure 4).

Figure 4. Professional representations of the role of learning environments in the cognitive development of students with SEN.

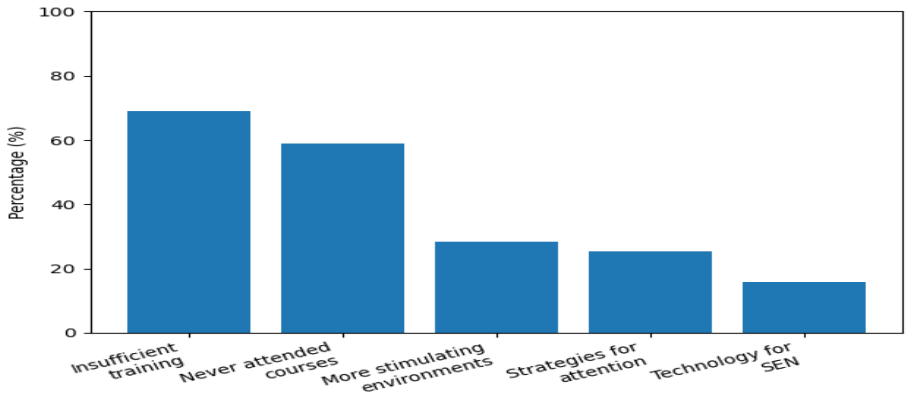


Declared Objective 5 – Perceived training needs.

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Findings highlight a clear demand for professional development. Sixty-nine percent of respondents consider current training in neuropedagogy insufficient, and 58.82% report never having attended specific courses. Priority areas include designing stimulating learning environments (28.42%), technology use in SEN education (15.79%), and strategies to support attention and concentration (25.26%) (Figure 5).

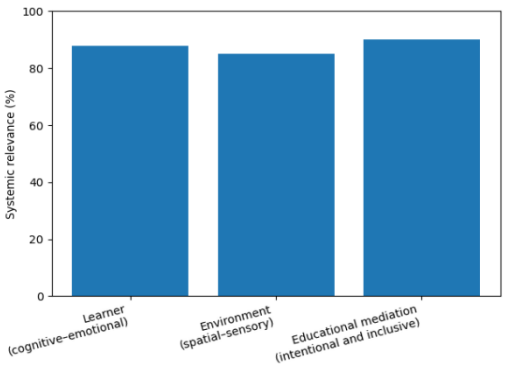
Figure 5. Perceived training needs related to neuropedagogy and the inclusive use of artificial intelligence among education professionals.



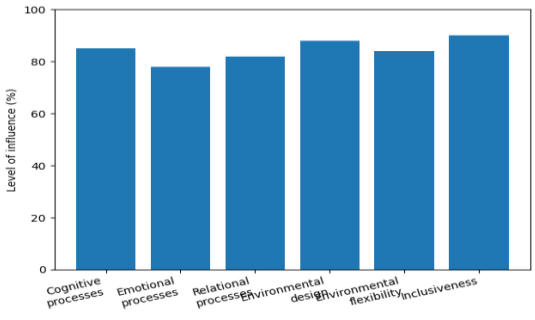
Overall, the findings depict cognitive adaptability in students with SEN as a systemic and emergent phenomenon arising from the dynamic interaction between learner, environment, and educational mediation (Figures 6–7).

Figure 6. Systemic relevance of learner, environment, and educational mediation in supporting cognitive adaptability in students with SEN.

Figure 7. Perceived level of influence of cognitive, emotional, relational, and environmental factors in supporting cognitive adaptability within intelligent learning environments.



(**6**)



(**7**)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Results should be interpreted considering the intentional, non-probabilistic sampling and the self-reported nature of the data, which limit generalizability and call for further research using larger and longitudinal designs.

4. Discussion

The present contribution adopts a research design based exclusively on descriptive statistical analyses applied to self-reported data, without the use of inferential procedures or methodological triangulation strategies. This choice, consistent with the exploratory and non-probabilistic nature of the sample, limits the possibility of identifying statistically significant relationships and of strengthening the interpretative validity of the findings. Nevertheless, in relation to the research objectives, the results allow for a critical reconsideration of the central research question, confirming that intelligent learning environments are perceived by education professionals as complex pedagogical configurations capable of influencing cognitive adaptability processes and inclusive dynamics among students with SEN. The strong convergence of perceptions regarding the structuring role of the environment in cognitive development points to a conception of learning as a situated and relational phenomenon, consistent with an on life vision of education that overcomes the dichotomy between physical and digital dimensions (Fiorese, 2025; Balzano, 2025).

The centrality attributed to multisensory stimulation, the quality of social interactions, and spatial flexibility suggests that cognitive adaptability is conceived as an emergent outcome of an articulated educational ecosystem, in which embodiment and experience play a constitutive role (Vitagliano, 2025). Findings related to the coherence between declared practices and neuropedagogical principles reveal a generally solid theoretical alignment, offering a meaningful representation of how teachers attribute meaning and effectiveness to their professional actions, despite the absence of causal inferences.

The analysis of educational technologies highlights a non-reductionist interpretative stance: digital tools are recognized as mediators of the educational experience rather than as automatically inclusive solutions, particularly in light of critical issues related to training, resources, and organizational constraints (Balzano, 2025). Overall, the results call for a systemic rethinking of the intelligent learning environment as a dynamic interplay of spaces, relationships, practices, and professional competences, opening avenues for further research aimed at integrating educational design with a neuropedagogical perspective.

5. Conclusions

The study's findings suggest relevant implications for educational practice as well as for training and organizational policies in school and higher education contexts. At an operational level, the results highlight the need to design learning environments as intentional ecosystems in which spatial, sensory, relational, and technological dimensions are coherently integrated in line with neuropedagogical principles, moving beyond episodic or merely instrumental interventions. Multisensory engagement, movement, and social interaction should be recognized as structural components of instructional design, while intelligent technologies should be used as mediators of educational experience, avoiding technocentric approaches. The teach-

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

er's role as a pedagogical mediator emerges as central. From a policy perspective, the findings underscore the urgency of investing in structured professional development focused on neuropedagogical foundations, intelligent learning environment design, and the ethical use of AI. At an organizational level, pedagogical governance of innovation, strengthened educational partnerships, and policies aimed at reducing inequalities appear essential.

References

Baldassarre, M., Sarcina, F. P., & Cuzzi, A. M. (2025). *Intelligenza artificiale ed embodied education: Un percorso didattico integrato per la scuola primaria*. Journal of Inclusive Methodology and Technology in Learning and Teaching, 5(2), 1–9.

Balzano, G. (2025). *L'educazione onlife al tempo della complessità*. Corpo, Società, Educazione, 2(2), 33–46. https://doi.org/10.14605/CSE222502.

Buccini, F., & Marone, F. (2025). *Intelligenza artificiale ed educazione: Nuove prospettive per l'inclusione*. IUL Research, 6(12), 292–303.

Creati, P., & Cuccaro, A. (2025). *Pedagogia speciale e intelligenza artificiale: Un umanesimo digitale per un'educazione inclusiva*. Italian Journal of Special Education for Inclusion, 13(1), 202–213.

Dipace, A. (2019). *Competenze digitali, nuovi ambienti di apprendimento e professionalità docente*. In Scienze umane tra ricerca e didattica. Atti del Convegno Internazionale di Studi (Vol. 2, pp. xx–xx). Il Castello.

Di Domenico, M., Schiavo, F., & Di Tore, P. A. (2025). *Artificial intelligence and embodiment: Conceptual borrowing and semantic drift*. Journal of Inclusive Methodology and Technology in Learning and Teaching, 5(2), 1–8.

Di Tore, P. A., Mangione, G. R. J., Zappalà, E., Barra, V., & Galdieri, M. (2021). *Spazio, tempo, corpo: Il "qui ed ora" di studenti e docenti negli ambienti di apprendimento ibridi*. Nuova Secondaria Ricerca.

Eugeni R. (2021), *Capitale algoritmico. Cinque dispositivi postmediali* (più uno), Brescia, Scholè.

Ferrantino, C., & Tiso, M. (2025). E*ducare con l'intelligenza artificiale: Possibilità e criticità nell'ambiente di apprendimento*. IUL Research, 6(12), 196–208.

Fiorese, G. (2025). *Strategie educative per l'era onlife: Una nuova frontiera educativa*. Corpo, Società, Educazione, 2(2), 115–136. https://doi.org/10.14605/CSE222507.

Floridi L. (2024), *Filosofia dell'informazione*, Milano, Raffaello Cortina Editore.

Mangione, G. R. J., & De Santis, F. (2024). *Intelligenza artificiale nei contesti educativi non standard: Esiti di una riflessione parlata sulle piccole scuole*. Scholé: Rivista di educazione e studi culturali, LXII(1).

Mirra, M., Campitiello, L., Bilotti, U., Rescigno, A., Stizzo, I., & Di Tore, S. (2025). *Impatto della realtà virtuale sull'apprendimento immersivo: Motivazione, partecipazione e percezione di studenti e docenti nella scuola secondaria*. Journal of Inclusive Methodology and Technology in Learning and Teaching, 5(4), 1–11.

Natalini, A. (2023). *Embodiment, ambienti (virtuali-reali) e digital survival: Verso un ecosistema educativo intelligente*. In REN. Ricerche in neuroscienze educative (pp. 146–147).

Pastena, N. (2020). *Innovazione in Educazione: prospettive epistemologiche e dinamiche professionalizzanti*. Formazione & insegnamento, 18(1_T1), 166-177.

Perciavalle, V. (2025). *Neurodivergent families and pedagogies of hybridization: Towards inclusive educational ecologies within post-digital transitions*. Journal of Inclusive Methodology and Technology in Learning and Teaching, 5(4), 1–8.

Perla, L., Amati, I., De Feo, A., Di Grassi, A., Forliano, R., & Santacroce, M. T. (2024). *Didattica algoretica e linee guida per la progettazione di ambienti di apprendimento human-centered.* Medical Humanities & Medicina Narrativa, 9(2), 183–200.

Poornesh M. (2024), *Through a teacher's lens: Combating bias in AI-powered education for a just future*, «The Clearing House: A Journal of Educational Strategies, Issues and Ideas», vol. 97, n. 4, pp. 119-124.

Rega, A., Di Fuccio, R., Inderst, E., & Limone, P. (2024). *Learning Enhancer Tools (LET): Un modello teorico per la progettazione di applicazioni educative basate sull'intelligenza artificiale*. Sistemi intelligenti, 36(3), 573–586.

Rosmansyah, Y., Putro, B. L., Putri, A., Utomo, N. B., & Suhardi. (2023). *A simple model of smart learning environment*. Interactive Learning Environments, 31(9), 5831-5852.

Selwyn, N. (2022). *The future of AI and education: Some cautionary notes*. European Journal of Education, 57(4), 620-631.

Vitagliano, K. (2025). *Tra traiettorie bioeducative e transizioni tecnologiche: Ricerche interdisciplinari per una contaminazione eco-logica*. Corpo, Società, Educazione, 2(2), 59–78. https://doi.org/10.14605/CSE222504.