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The Reflexive Teacher and the Semiotics of Learning: An Umwelt-Based Account of Didactic Transposition

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Abstract: This article reconceptualizes didactic transposition as a semiotics of learning grounded in Jakob von Uexküll's concept of *Umwelt* and in teacher reflexivity as a core pedagogical competence. Moving beyond traditional views of transposition as content simplification or sequencing, the paper argues that learning is a biosemiotic, situated, and co-constructive process in which learners integrate new knowledge into subjective, meaning-laden worlds shaped by embodied, cultural, linguistic, and technological experiences. From this perspective, teaching is understood as semiotic mediation: an interpretative practice through which teachers design, orchestrate, and regulate semiotic pathways that enable disciplinary knowledge to become intelligible and meaningful across plural Umwelten. Particular attention is given to the role of digital technologies and artificial intelligence, which increasingly extend learners' semiotic environments by introducing adaptive feedback, multimodal representations, and generative outputs. While these tools expand educational affordances, their pedagogical value depends on reflexive teacher mediation capable of aligning technological signs with curricular goals, cultural frameworks, and ethical considerations. The article positions teacher reflexivity as both an epistemic and professional competence that supports inclusion, interpretive flexibility, and culturally sustaining pedagogy in heterogeneous classrooms. By integrating biosemiotic theory, semiotics of learning, and contemporary educational technology, the paper offers a theoretical framework and practical implications for curriculum design, assessment, and teacher education in complex, AI-augmented learning ecologies.

Keywords: Teacher reflexivity; Didactic transposition; AI Education; Embodied-Education.

1. Introduction

The process of making disciplinary knowledge teachable, traditionally conceptualized as *didactic transposition*, has long been interpreted as a simplification or adaptation of content for students (Chevallard, 1985; Perrenoud, 1998). Within the classical educational perspective, transposition focuses on transforming academic knowledge so that it can be delivered in school, through successive restructuring of content and sequences of activities specific to educational contexts (Chevallard, 1985; Bjelde, 2021; Winsløw et al., 2024). While operationally useful, this model often neglects students' individual semiotic horizons and the active ways in which they construct meaning (Campbell et al., 2019). This article proposes a reconceptualization of

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didactic transposition from a bioeducational and biosemiotic perspective (Frauenfelder, 2004; Frauenfelder et al., 2013), interpreting it as a *semiotics of learning*. Here, the novelty does not lie in reversing the flow of knowledge—whether from the student toward the scholarly knowledge or vice versa—but in framing transposition as a process through which disciplinary content is translated and adapted within students' subjective worlds, leveraging their perceptual, cognitive, emotional, and functional resources. In other words, transposition becomes a means to guide students' semiotic and cognitive capacities toward disciplinary understanding, rather than treating them as passive recipients of pre-formed knowledge. Contemporary classrooms, characterized by cultural heterogeneity, differences in perceptual, cognitive, and functional dispositions, and diverse prior experiences, foreground the complexity of such mediation (Uexküll, 2017; Goldin-Meadow et al., 2015). Students interpret educational phenomena through their own experiential worlds, shaped by embodied histories, cultural practices, and individual semiotic systems. These experiences are increasingly mediated by digital technologies and artificial intelligence (AI), which introduce complex networks of interactions, representations, and adaptive feedback (Mitchell, 2006; Zhou et al., 2024). Tools such as interactive simulations, augmented and virtual reality environments, collaborative platforms, and AI-based personalized learning systems expand students' perceptual and cognitive capacities, generating semiotic configurations that guide meaning-making (Holmes et al., 2019; Glickman & Sharot, 2025). In this context, technologies do not function merely as channels for content delivery but as active agents within the classroom semiotic ecology, requiring intentional pedagogical mediation to harness the plurality of emergent interpretations (Schiavo et al., 2025).

Our proposed reconceptualization of didactic transposition draws on Jakob von Uexküll's concept of *Umwelt*, framing transposition as a semiotics of learning (Kruis, 2014). *Umwelt* refers to the organism-specific subjective world, emerging from functional interactions with the environment and structured by perceptual and operational relations that constitute meaningful semiotic systems (Uexküll, 2017; Tønnessen & Brentari, 2016). Contemporary biosemiotic research further highlights the recursive nature of signification and organisms' active engagement in co-constructing meaning (Kull, 2022; Kull & Velmezova, 2024; Zengiaro, 2023). From this perspective, learning is not passive reception of content but the situated integration of new signs, distinctions, and relations into students' semiotic horizons, supported by digital tools and AI as facilitators of supplementary semiotic pathways (Sibilio et al., 2023). Teaching, within this framework, is an interpretative practice in which instructors mediate disciplinary knowledge across multiple *Umwelten*, translating content into semiotically accessible and operational configurations for heterogeneous students (Aiello et al., 2013). Mediation entails selection, sequencing, and transformation of content, making it interpretable both through direct interaction and via digital tools or AI-generated outputs (Goldin-Meadow et al., 2015; Ciccarelli & Tafuri, 2024). Navigating between human and technological semiotic inputs requires systematic teacher reflexivity, conceived as an epistemic and cognitive stance that deliberately regulates interpretive processes and conditions of signification (Dewey, 1910; Finlay, 2002; Pillow, 2003; Schön, 2017; Selwyn, 2020). Reflexivity involves continuous attention to teacher assumptions, interpretive models embedded in AI systems, and implicit classroom norms.

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In sum, conceptualizing didactic transposition as a semiotics of learning, with teacher reflexivity at its core, allows the integration of biological, cultural, symbolic, and technologically mediated dimensions of learning (Bagni & D'Amore, 2005; Kull, 2022). In pluralistic and technologically complex contexts, educational effectiveness increasingly depends on the ability to orchestrate human and AI-generated semiotic inputs. Reflexivity thus becomes a structural and indispensable condition of contemporary education, capable of supporting the construction of individual meanings, recognition of semiotic diversity, and the development of critical, integrative competencies.

2. The Concept of Umwelt: Subjectivity, Meaning, and Educational Implications

A perspective informed by *Umwelt* reconceives learning as a biosemiotic, socially situated, and contextually grounded process, in which students inhabit multiple, dynamic, and meaning-rich worlds (Aiello & Sibilio, 2012). Jakob von Uexküll's notion of *Umwelt* emphasizes that an organism's experience is inherently subjective, shaped by the interplay between perceptual capacities, operational tools, and environmental stimuli (Uexküll; Tønnessen & Brentari, 2016). Applied to education, this perspective highlights that knowledge is not passively received but actively constructed through semiotic interaction with signs, embodied experiences, and social engagement (Aiello et al., 2013). Students continuously interpret and integrate new signs into their experiential horizons, which are themselves influenced by prior knowledge, cultural and linguistic resources, bodily dispositions, and personal histories (Stables et al., 2018; Fosnot, 2013; Vygotsky, 1978). Divergent responses to the same instructional content should not be interpreted as deficits; rather, they reflect distinct semiotic pathways and individualized modes of meaning-making, highlighting the richness and heterogeneity of classroom semiotic ecologies.

Educational practice should therefore be understood as deliberate semiotic mediation rather than mere content adaptation. Teachers design learning environments, tasks, and interactions that invite students to rework and reconfigure signs in ways that resonate with their subjective worlds (Deni & Zingale, 2018). This includes diverse semiotic resources: spoken and written language, visual representations, gestures, embodied experiences, digital tools, and technological interfaces (Bezemer & Kress, 2015). For instance, interactive simulations can model ecological processes, allowing students to manipulate variables and observe tangible effects, thereby linking abstract concepts to perceptible embodied experiences. Similarly, multimodal representations diagrams combined with verbal explanations or gesture-supported mathematical demonstrations can facilitate entry into complex content. Digital tools and AI further enrich this semiotic ecology by providing personalized suggestions, feedback, and examples aligned with students' prior knowledge and preferred learning styles (Holmes et al., 2019). In these contexts, the teacher's role is not supplanted but enhanced: they interpret AI-generated outputs, guide critical reflection, and ensure that technologically mediated signs are meaningfully integrated into students' *Umwelten* (Todino et al., 2016).

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Semiotic approaches challenge simplistic dichotomies between internal cognitive processes and external stimuli, emphasizing learning as a transactional, embodied, and context-sensitive engagement with signs, objects, and other participants (Kress, 2010; Di Paolo, Rohde & De Jaegher, 2022). Student subjectivity is not an add-on to cognition but co-constituted through semiosis, underscoring that ethical and relational dimensions are inseparable from educational practice (Deely & Semetsky, 2017). Every instructional decision—whether emphasizing a particular diagram, modeling a problem-solving strategy, or providing an AI-generated prompt—affects the semiotic pathways through which students construct understanding and meaning. Within these semiotic ecologies, teachers assume an intrinsically interpretive and reflexive role. Effective semiotic mediation requires observing how students integrate multiple modes of expression - verbal, diagrammatic, gestural, digital, and multimodal - into their emerging worlds of meaning, while simultaneously regulating the teacher's own interpretive processes to account for implicit assumptions, classroom norms, and the structural affordances of technological tools, including AI systems (Schön, 1983/1987; Pillow, 2003; Selwyn, 2020). For example, when students use generative AI tools to produce summaries of historical events, the teacher guides them in evaluating accuracy, identifying implicit assumptions, and integrating new content with prior knowledge. In collaborative digital projects, teachers observe how students negotiate meaning through shared interfaces, providing prompts that highlight distinctions and connections, safeguarding interpretive diversity, and supporting learning.

In this sense, learning is fundamentally co-constructed: knowledge and meaning emerge from continuous interaction, negotiation, embodied engagement, and reflective participation, rather than from the passive transmission of standardized content (Stables et al., 2018; Deely & Semetsky, 2017). This approach underscores the need for flexible, responsive pedagogical strategies sensitive to the semiotic richness of students' experiences. Teachers must balance guidance and openness, allowing students to explore, question, and reinterpret content while maintaining coherent pathways toward understanding. By strategically designing semiotic conditions, selecting and sequencing signs, and integrating digital tools and AI with reflective pedagogical oversight, educators support students in navigating complex content while preserving interpretive autonomy and diversity.

3. Didactic Transposition as a Semiotics of Learning

From an *Umwelt* perspective, didactic transposition extends beyond mere adaptation or simplification of disciplinary content, as often assumed in traditional models (Chevallard, 1985; Winsløw et al., 2024). Rather, it constitutes a complex semiotic process in which knowledge is transformed into networks of meaningful signs interpretable within students' subjective horizons. The novelty of this approach does not lie in reversing the flow between disciplinary knowledge and learners, but in conceiving transposition as an orchestration of signs and meanings that leverages students' cognitive, emotional, and functional resources, guiding them toward advanced disciplinary understanding. Traditional models, while offering operational guidance, often overlook students' situated and meaning-rich worlds and the interpretive work required to integrate new knowledge (Lave & Wenger, 1991; Sfard,

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1998). The biosemiotic perspective foregrounds active student engagement, recognizing that each individual interprets educational phenomena through prior experiences, cultural and linguistic resources, bodily dispositions, and idiosyncratic perceptual capacities (Uexküll, 1934/2010; Tønnessen et al., 2016). Cognition is distributed, embodied, and socially situated (Clark, 1998; Varela, Thompson & Rosch, 1991), and learning involves integrating new semiotic relations into pre-existing networks in ways that are meaningful, coherent, and actionable (Rogoff, 2003; Wertsch, 1998). Students do not passively receive information; rather, they interpret, negotiate, and integrate linguistic, visual, gestural, mathematical, and digital signs into their cognitive and experiential schemas (Chandler, 2022; Deely & Semetsky, 2017; Jewitt, 2009). In mathematics, for instance, symbolic notation may be supported by dynamic digital graphs, gestural explanations, and verbal reasoning, facilitating connections between abstract representations and embodied understanding (Mariotti & Maffia, 2018). In science, interactive simulations and models allow students to manipulate variables, observe emerging patterns, and link theoretical content to perceptible experiences. These examples illustrate that knowledge emerges relationally and co-constructively, through the interaction of teacher, student, and content, mediated by semiotic structures orchestrated by the educator (Gensini, 2016; Sessa & Aiello, 2025; Laurillard, 2012). Central to this process is teacher reflexivity, understood as both an epistemic and professional competence. Reflective educators continuously monitor interpretive habits, attentional focus, and assumptions, avoiding the imposition of a single normative perspective (Di Tore et al., 2020). They attend to how cultural, linguistic, and technological mediators—including AI explanations, digital simulations, and collaborative platforms—shape students' semiotic pathways (Schön, 1983/1987; Beauchamp, 2015). Reflexivity creates cognitive and semiotic space for alternative meanings, supporting the exploration of multiple interpretations and conceptual pathways. Ethical considerations are integral to this process: unexamined scaffolding or instructional cues may privilege certain modes of knowledge while marginalizing others. Reflexive mediation fosters equitable learning environments, culturally sustainable pedagogy, and inclusive recognition of students' semiotic resources (Florian, 2014; Slee, 2018; Paris & Alim, 2017).

Within this framework, teaching becomes a form of bio-educational mediation: educators design and orchestrate semiotic pathways that enable students to integrate new knowledge without flattening the complexity of their subjective worlds. In contexts with AI-mediated simulations, teachers guide students in critically comparing algorithmically generated predictions with empirical observations, stimulating reflection on implicit assumptions and connecting outcomes to prior knowledge and lived experiences. In sum, didactic transposition, reconceptualized through the semiotic lens of *Umwelt*, is neither linear nor purely technical; it is a co-constructive and interpretive process. Reflexivity allows educators to anticipate and respond to how students comprehend content, ensuring adaptive, inclusive, and ethically grounded instruction. By attending to the semiotic richness of students' *Umwelten*, educators create environments in which knowledge traverses multiple subjective worlds, promoting critical understanding, learner autonomy, and meaningful integration of disciplinary content (Sessa & Aiello, 2025).

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4. Extending Umwelten: Digital Technologies and Artificial Intelligence

In contemporary educational contexts, digital technologies and artificial intelligence (AI) systems extend far beyond content delivery; they operate as extensions of students' *Umwelten*, enriching their subjective worlds with complex networks of signs, interactions, and adaptive feedback (Holmes et al., 2019; Luckin et al., 2016). Adaptive learning platforms, for example, analyze engagement patterns and dynamically adjust activity sequences, scaffolding, and pacing to support individualized learning trajectories (VanLehn, 2011). Intelligent tutoring systems provide context-sensitive and targeted feedback, updating mastery profiles in real time and offering corrective guidance to foster conceptual understanding and the integration of new signs (Heffernan & Heffernan, 2014). Generative AI tools, including agents based on large language models, enable the creation of explanations, examples, and interactive scenarios on demand, producing multiple semiotic pathways tailored to each student's context. These technologies expand opportunities for exploring complex concepts across diverse semiotic modes—verbal, visual, gestural, and digital—allowing students to manipulate, integrate, and negotiate signs within their subjective worlds (Holmes et al., 2019; Glickman & Sharot, 2025; Sibilio et al., 2023). Crucially, access to digital or AI-mediated tools does not automatically guarantee meaningful learning. Their effectiveness depends on reflective teacher mediation, functioning as a semiotic curator: educators evaluate the relevance and accuracy of AI-generated outputs, integrate them coherently with curricular objectives, and guide students in interpreting content relative to their cultural, cognitive, and affective contexts (Schön, 1983/1987; Zeichner & Liston, 2013). For instance, when an AI system generates multiple solutions to a scientific problem, teachers can orchestrate comparative analysis among students, prompting reflection on implicit assumptions, highlighting emerging patterns, and connecting new knowledge to prior understanding (Aiello et al., 2013; Holmes et al., 2019). Teacher reflexivity is also essential for identifying and mitigating algorithmic biases, calibrating scaffolding according to cognitive and cultural differences, and preventing overreliance on automated feedback, thereby preserving critical thinking, autonomy, and student agency (Eubanks, 2018; Selwyn, 2020).

Within this framework, digital technologies and AI do not replace the teacher; rather, they amplify students' capacity to explore and construct meaning within a dynamic semiotic ecosystem. Human mediation, technological tools, and cultural contexts co-construct meaningful, situated learning pathways, transforming didactic transposition into an interpretive and relational process. In this model, learning is neither linear nor passive, but co-constructed through the integration of cognitive, emotional, and social competencies, with students' subjective worlds serving as the focal point of the educational experience (Sessa & Aiello, 2025; Todino et al., 2016).

5. Discussion: Reflexive Mediation and Pedagogical Implications

Teacher reflexivity constitutes a critical epistemic and professional competence, enabling educators to regulate interpretive processes, formulate context-sensitive judgments, and implement ethically grounded and inclusive practices (Sessa & Aiello, 2025). It extends beyond retrospective reflection, requiring continuous monitoring of assumptions, attentional foci, and interpretive habits in order to ensure that students'

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semiotic experiences are recognized and valued within instructional settings (Beauchamp, 2015; Pace, 2025). Reflexivity can be systematically developed through structured pedagogical practices such as video analysis, the examination of minimally contextualized instructional sequences, AI-generated simulations, and interactive digital environments (Russell, 1996; Carlson, Moses & Breton, 2002; Sibilio, Aiello & Di Tore, 2013). These practices support the differentiation between observation and interpretation, suspend automatic judgments, and create cognitive space for alternative meanings, thereby fostering interpretive flexibility and adaptive expertise (Sessa & Aiello, 2025). A reflexive stance is central to the promotion of inclusion, equity, and culturally responsive pedagogy (Florian, 2014; Paris & Alim, 2017; Slee, 2018). By attending to students' linguistic, embodied, cultural, and digital semiotic resources, teachers can design learning trajectories that legitimize diverse ways of knowing and acting. Reflective mediation also guides students' engagement with AI-generated outputs, digital simulations, and other semiotic cues, supporting critical evaluation, integration into existing meaning-making frameworks, and awareness of the assumptions embedded in technological systems (Holmes et al., 2019). Curricula informed by reflexivity accommodate multiple semiotic pathways and promote diversified forms of epistemic engagement, enabling students to construct knowledge rather than merely reproduce content (Rogoff, 2003; Vygotsky, 1978). Accordingly, assessment practices should address interpretive processes, collaborative problem solving, and students' capacity to integrate information from multiple sources, including AI-mediated ones (Sadler, 2013; Andrade & Cizek, 2010). Teacher education thus plays a pivotal role, as it must explicitly cultivate metacognitive and reflexive competencies, preparing educators to operate with epistemic rigor and ethical sensitivity in heterogeneous and technologically enriched classrooms (Hargreaves, 2005). Within this framework, didactic transposition—reinterpreted as a semiotics of learning—is grounded in Jakob von Uexküll's concept of *Umwelt* and sustained by structured, trainable reflexivity. Teaching is thereby configured as bio-educational mediation: a co-constructive process operating across heterogeneous *Umwelten* that preserves interpretive diversity and cultural responsiveness (Sessa & Aiello, 2025; Goldin-Meadow et al., 2015). Reflexive teachers anticipate and respond to students' meaning-making processes by orchestrating human and AI-mediated semiotic inputs in ways that foster cognitive integration, agency, and ethically oriented participation (Aiello, 2019). Educators thus design semiotic conditions through which knowledge enters students' subjective worlds in perceptible, interpretable, and meaningful forms, without flattening the complexity of their *Umwelten* (Di Gennaro et al., 2014). This model integrates biological, cognitive, cultural, and technological dimensions of learning, supporting inclusive, adaptive, and intellectually generative pedagogical practices (Frauenfelder, 2011). It offers a coherent theoretical–practical framework for addressing complex and technologically dense educational ecologies while safeguarding pedagogical coherence, student agency, and equity. Future research should examine the longitudinal effects of reflexivity-oriented teacher education, the interactions between AI-mediated semiotic environments and learning outcomes, and the scalability of bio-educational mediation within teacher training programs (Fenwick, 2019; Panadero, 2017). By positioning reflexivity at the core of semiotic mediation, this model delineates operational pathways for engaging diverse learners in ways that are both ethically grounded and epistemically robust.

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References

Aiello, P., D'Elia, F., Di Tore, S., & Sibilio, M. (2012). A constructivist approach to virtual reality for experiential learning. *E-learning and Digital Media*, *9*(3), 317-324.

Aiello, P., & Sibilio, M. (2012). The potentials of bodily experience in the construction of knowledge:" bodily-dynamic concept maps" as teaching-learning proposal for" meaningful learning". *Journal of Physical Education and Sport*, *12*(3), 284.

Aiello, P., Di Tore, S., Di Tore, P. A., & Sibilio, M. (2013). Didactics and simplexity: Umwelt as a perceptive interface. *Education Sciences & Society: 1, 2013*, 27-35.

Aiello, P. (2019). Teacher Education e Induction Period. Agentività del docente e sostenibilità di modelli formativi. *Nuova Secondaria*, 58-61.

Andrade, H., & Cizek, G. J. (Eds.). (2010). *Handbook of formative assessment*. Routledge.

Bagni, G. T., & D'Amore, B. (2005). Epistemologia, sociologia, semiotica: la prospettiva socio-culturale. *La matematica e la sua didattica*, *19*(1), 73-89.

Beauchamp, C. (2015). Reflection in teacher education: issues emerging from a review of current literature. *Reflective practice*, *16*(1), 123-141.

Bjelde, J. (2021). Knowledge is teachable. *Mind*, *130*(518), 475-502.

Pace, E. M. (2025). DEFINING A CONCEPTUAL FRAMEWORK FOR TEACHER PROFESSIONAL IDENTITY DEVELOPMENT: A THEORETICAL REFLECTION. In *ICERI2025 Proceedings*(pp. 4784-4790). IATED.

Bezemer, J., & Kress, G. (2015). *Multimodality, learning and communication: A social semiotic frame*. Routledge.

Winsløw, C., Bosch, M., González-Martín, A. S., & Huo, R. (2024). Technology in university mathematics education. In *Handbook of digital resources in mathematics education* (pp. 823-849). Cham: Springer International Publishing.

Campbell, C., Olteanu, A., & Kull, K. (2019). Learning and knowing as semiosis: Extending the conceptual apparatus of semiotics. *Sign systems studies.*, *47*(3-4), 352-381.

Deni, M., & Zingale, S. (2018). Semiotica e didattica del design. *La didattica del design in Italia*, 96-107.

Di Gennaro, D. C., Pace, E. M., Zollo, I., & Aiello, P. (2014). TEACHER CAPACITY BUILDING THROUGH CRITICAL REFLECTIVE PRACTICE FOR THE PROMOTION OF INCLUSIVE EDUCATION. *Problems of Education in the 21st Century*, *60*.

Di Tore, S., Aiello, P., Sibilio, M., & Berthoz, A. (2020). Simplex didactics: promoting transversal learning through the training of perspective taking. *Journal of e-Learning and Knowledge Society*, *16*(3), 34-49.

Gensini, S. (2016). IL PROBLEMA SEMIOTICO DEL TESTO FRA RICERCA E DIDATTICA di. *La centralità del testo nelle pratiche didattiche*, 52.

Goldin-Meadow, S., & Brentari, D. (2017). Gesture, sign, and language: The coming of age of sign language and gesture studies. *Behavioral and brain sciences*, *40*, e46.

Glickman, M., & Sharot, T. (2025). How human–AI feedback loops alter human perceptual, emotional and social judgements. *Nature Human Behaviour*, *9*(2), 345-359.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development: An International Journal of Research and Practice*, *11*(2), 73-92.

Chandler, D. (2022). *Semiotics: the basics*. Routledge.

Chevallard, Y., & Johsua, M. A. (1985). *La transposition didactique: du savoir savant au savoir enseigné*. La Pensée Sauvage,.

Clark, A. (1998). *Being there: Putting brain, body, and world together again*. MIT press.

Ciccarelli, S., & Tafuri, M. G. (2024). Embodied digital learning: New educational scenarios between artificial intelligence and the rediscovery of corporeality. *Journal of Inclusive Methodology and Technology in Learning and Teaching*, *4*(1).

Deely, J., & Semetsky, I. (2017). Semiotics, edusemiotics and the culture of education. *Educational Philosophy and Theory*, *49*(3), 207-219.

Di Paolo, E. A., & De Jaegher, H. (2022). Enactive ethics: Difference becoming participation. *Topoi*, *41*(2), 241-256.

Di Paolo, A., Sessa, C., & Sibilio, M. (2024). From game to videogame: the didactic design between real and virtual game in an inclusive and simplexity way. *Journal of Inclusive Methodology and Technology in Learning and Teaching*, *4*(3).

Dewey, J. (1910). How we think. DC Heath & Co. *Boston, Mass*, *224*.

Eubanks, V. (2018). *Automating inequality: How high-tech tools profile, police, and punish the poor*. Macmillan+ ORM.

Fenwick, T. J., & Edwards, R. (Eds.). (2019). *Revisiting actor-network theory in education*. London: Routledge.

Florian, L. (2014). What counts as evidence of inclusive education?. *European journal of special needs education*, *29*(3), 286-294.

Frauenfelder, E. (2004). Introduzione alle scienze bioeducative.

Frauenfelder, E. (2011). Una dinamica dialogica per la nascita delle Scienze bioeducative. *Studi Sulla Formazione/Open Journal of Education*, *14*(1), 7-17.

Frauenfelder, E., Rivoltella, P. C., Rossi, P. G., & Sibilio, M. (2013). Bio-education, simplexity, neuroscience and enactivism: a new paradigm?. *Education Sciences & Society: 1, 2013*, 11-25.

Fosnot, C. T. (2013). *Constructivism: Theory, perspectives, and practice*. Teachers College Press.

Finlay, L. (2002). "Outing" the researcher: the provenance, process, and practice of reflexivity. *Qualitative health research*, *12*(4), 531-545.

Hargreaves, A. (2005). Educational change takes ages: Life, career and generational factors in teachers' emotional responses to educational change. *Teaching and teacher Education*, *21*(8), 967-983.

Heffernan, N. T., & Heffernan, C. L. (2014). The ASSISTments ecosystem: Building a platform that brings scientists and teachers together for minimally invasive research on human learning and teaching. *International Journal of Artificial Intelligence in Education*, *24*(4), 470-497.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education promises and implications for teaching and learning*. Center for Curriculum Redesign.

Jewitt, C. (Ed.). (2009). *The Routledge handbook of multimodal analysis* (Vol. 1). London: Routledge.

Kruis, J. (2014). Expanding Umwelt Theory: From Structural Linguistics to Cognitive Learning. *Chinese Semiotic Studies*, *10*(3), 497-507.

Kull, K., & Velmezova, E. (2024). Semiotics now. *Sign Systems Studies*, *52*(3-4), 543-593.

Laurillard, D. (2013). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Luckin, R., & Holmes, W. (2016). Intelligence unleashed: An argument for AI in education.

Mariotti, M. A., & Maffia, A. (2018). Dall'utilizzo degli artefatti ai significati matematici: il ruolo dell'insegnante nel processo di mediazione semiotica. *Didattica della matematica. Dalla ricerca alle pratiche d'aula*, (4), 50-64.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in psychology*, *8*, 422.

Paris, D., & Alim, H. S. (Eds.). (2017). *Culturally sustaining pedagogies: Teaching and learning for justice in a changing world*. Teachers College Press.

Perrenoud, P. (1998). La transposition didactique à partir de pratiques: des savoirs aux compétences. Revue des sciences de l'éducation, 24 (3), pp. 487-514.

Pillow, W. (2003). Confession, catharsis, or cure? Rethinking the uses of reflexivity as methodological power in qualitative research. *International journal of qualitative studies in education*, *16*(2), 175-196.

Russell, J., Jarrold, C., & Henry, L. (1996). Working memory in children with autism and with moderate learning difficulties. *Journal of child psychology and psychiatry*, *37*(6), 673-686.

Sadler, D. R. (2013). Making competent judgments of competence. In *Modeling and measuring competencies in higher education: Tasks and challenges* (pp. 13-27). Rotterdam: SensePublishers.

Schiavo, F., Mangione, G. R. J., Di Domenico, M., & Di Tore, P. A. (2025). Towards a Somatic Pedagogy of Artificial Intelligence: interdisciplinary reflections between Embodied Cognition and Educational Design. *Journal of Inclusive Methodology and Technology in Learning and Teaching*, *5*(2).

Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Routledge.

Sessa, C., & Aiello, P. (2024). CAN MY CO-TEACHER BE A CHATBOT?. In *ICERI2024 Proceedings* (pp. 8322-8329). IATED.

Sessa, C., & Aiello, P. (2025). ENHANCING REFLECTIVE AND METACOGNITIVE COMPETENCES IN TEACHER EDUCATION FOR THE INCLUSION OF STUDENTS WITH AUTISM SPECTRUM DISORDER. *ITALIAN JOURNAL OF HEALTH EDUCATION, SPORT AND INCLUSIVE DIDACTICS*, *9*(1).

Selwyn, N. (2019). *Should robots replace teachers?: AI and the future of education*. John Wiley & Sons.

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational researcher*, *27*(2), 4-13.

Sibilio, M., Di Tore, S., Todino, M. D., Lecce, A., Viola, I., & Campitiello, L. (2023, July). MetaWelt: embodied in which body? Simplex didactics to live the web 3.0. In *International Conference on Human-Computer Interaction* (pp. 111-119). Cham: Springer Nature Switzerland.

Slee, R. (2018). *Inclusive education isn't dead, it just smells funny*. Routledge.

Tønnessen, M., Magnus, R., & Brentari, C. (2016). The biosemiotic glossary project: Umwelt. *Biosemiotics, 9*(1), 129–149. https://doi.org/10.1007/s12304-016-9255-6.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational psychologist*, *46*(4), 197-221.

Rosch, E., Thompson, E., & Varela, F. (1991). The Embodied Mind: Cognitive Science and Human Experience, by Cambridge.

Todino, M. D., Aiello, P., & Sibilio, M. (2016). Flexible classrooms for inclusive education. In *ICERI2016 Proceedings* (pp. 1674-1678). IATED.

Kim, M. Y., & Wilkinson, I. A. (2019). What is dialogic teaching? Constructing, deconstructing, and reconstructing a pedagogy of classroom talk. *Learning, Culture and Social Interaction*, *21*, 70-86.

Kull, K. (2022). Gatherings in Biosemiotics 2022, Book of Abstracts (Umwelt analysis, etc.). *Gatherings in Biosemiotics 2022*.

Zeichner, K. M., & Liston, D. P. (2013). *Reflective teaching: An introduction*. Routledge.

Zhou, D., Xue, X., Lu, X., Guo, Y., Ji, P., Lv, H., ... & Cui, L. (2024). A hierarchical model for complex adaptive system: From adaptive agent to ai society. *ACM Transactions on Autonomous and Adaptive Systems*.

Zou, D., Xie, H., & Hmelo-Silver, C. E. (2024). Generative AI in STEM education: Opportunities for scaffolded semiotic learning. *Computers & Education, 202*, 104837. https://doi.org/10.1016/j.compedu.2023.104837