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From Cognition to Connection: Ecological-Connective Clues in History Teaching within OnLIFE Education

Da cognição à conexão: pistas ecológico-conectivas no ensino de História na Educação OnLIFE

De la cognición a la conexión: pistas ecológico-conectivas en la enseñanza de Historia en la Educación OnLIFE

Eliane Schlemmeri [a]
São Leopoldo, RS, Brasil
Universidade do Vale do Rio dos Sinos - Unisinos

Natália Sitnievski [b]
São Leopoldo, RS, Brasil
Universidade do Vale do Rio dos Sinos - Unisinos

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Abstract

In contemporary times, marked by hyperconnectivity and generative and agentic artificial intelligences that expand the possibilities of co-creating formative environments in ecologically connected contexts, the educational debate has been strained by the need for pedagogical practices that overcome dualisms and centralities, favoring more connective and reflective forms of learning. In this scenario, traditional perspectives on metacognition prove limited in the face of the

[a] PhD in Educational Informatics from the Federal University of Rio Grande do Sul (UFRGS), CNPq Research Productivity Fellow, Professor in the Graduate Program in Education at the University of Vale do Rio dos Sinos (Unisinos), and Coordinator of the Digital Education Research Group (Unisinos/CNPq). E-mail: elianes@unisinos.br
[b] Master's degree holder and PhD candidate in Education in the Graduate Program in Education at the University of Vale do Rio dos Sinos (Unisinos). Member of the International Digital Education Research Group (GPe-dU). E-mail: sitnievski46@gmail.com

transformations of our living conditions. In this context, this article aims to understand how ecological-connective pedagogical practices, guided by the OnLIFE Education Paradigm (Schlemmer, 2020) and Ecological Thinking (Morton, 2023), problematize conceptions of metacognition in the teaching of History. Methodologically, this is an intervention-research project based on the Cartographic Method, developed from the ecological-connective pedagogical practice entitled "In the Wine Capital for 150 days! U.V.A. Expedition in Bento Gonçalves Soil," carried out with third-year high school students throughout 2025. The results indicate that reflective processes about learning emerged as ecological-connective phenomena produced in the relationships between students, digital technologies, artificial intelligence, the city, memory, and experience.

Keywords: *Metacognition. OnLIFE Education Paradigm. History Teaching. Connective Ecologies.*

Resumo

Na contemporaneidade, marcada pela hiperconectividade, pelas inteligências artificiais generativas e agênticas as quais ampliam as possibilidades de cocriar ambientações formativas em contextos ecologicamente conectadas, o debate educacional vem sendo tensionado pela necessidade de práticas pedagógicas que superem os dualismos e as centralidades, favorecendo formas mais conectivas e reflexivas de aprendizagem. Nesse cenário, perspectivas tradicionais de metacognição mostram-se limitadas diante das transformações da nossa condição habitativa. Nesse contexto, este artigo objetiva compreender de que maneira práticas pedagógicas ecológico-conectivas, orientadas pelo Paradigma da Educação OnLIFE (Schlemmer, 2020) e do Pensamento Ecológico (Morton, 2023), problematizam concepções de metacognição no ensino de História. Metodologicamente, trata-se de uma pesquisa-intervenção fundamentada no Método Cartográfico, desenvolvida a partir da prática pedagógica ecológico-conectiva intitulada "Na Capital do Vinho por 150 dias! Expedição da U.V.A em Solo Bento-gonçalvense", realizada com estudantes da terceira série do Ensino Médio ao longo de 2025. Os resultados indicam que os processos reflexivos acerca da aprendizagem emergiram como fenômenos ecológico-conectivos produzidos nas relações entre estudantes, tecnologias digitais, inteligências artificiais, cidade, memória e experiência.

Palavras-chave: *Metacognição. Paradigma da Educação OnLIFE. Ensino de História. Ecologias-conectivas.*

1. Introduction[1]

> Bacterium, fungus, whale, sequoia: we know of no living being that does not emit, receive, store, and process information [...] Crystal, rock, sea, planet, star, galaxy: we no longer know of any inert thing that does not emit, receive, store, and process information [...] Individual, family, farm, village, metropolis, nation: we know of no human being, alone or in groups, that does not emit, receive, store, and process information. (Serres, 1990, translated)

Reflecting on thinking itself was the challenge proposed by the American psychologist John A. Flavell in the 1970s[2]. Based on his studies, Flavell coined the term *metacognition*[3] to describe the knowledge individuals have about their own cognitive processes, their ability to monitor, regulate, and evaluate their own thinking or, more succinctly, to "think about one's own thinking." However, Michel Serres' reflection in the epigraph of this article inspires us to problematize this understanding, as it shifts the notion of thought away from something exclusively human, individual, and internal.

By asserting that bacteria, fungi, rocks, seas, cities, and galaxies emit, receive, store, and process information, Serres challenges the anthropocentric centrality of cognition. Thought ceases to be understood as the exclusive privilege of the rational human mind and instead becomes a phenomenon distributed across connective ecologies. From this perspective, metacognition transubstantiates: it is no longer merely the monitoring of internal cognitive processing but becomes an awareness of our participation in the informational and agentic flows of the world.

In this sense, James Lovelock's (1979) Gaia Hypothesis itself introduced significant ruptures in Western rationality, by demonstrating that we no longer inhabit a merely terrestrial planet but are instead part of a living organism composed of millions of other organisms. Nevertheless, "the social sciences, born in the height of positivism and grounded in the anthropomorphic assumptions of Western thought, produced a notion of society and community limited solely to humans" (Di Felice, 2020, p. 11, translated). Thus, it becomes evident that traditional Western concepts of separation “those opposing humanity to the environment, technology, and nature are replaced by the ecosystemic perception of a mode of inhabiting that redefines every entity no longer as an autonomous reality but as part of a relational form” (Ibid., p. 43).

Geological studies themselves support this perspective by attributing a historical and ever-changing dimension to the Earth. In problematizing the concept of the Anthropocene[4], which views only humans as agents capable of driving structural transformations, Donna Haraway (2016) proposes the concept of the *Chthulucene*. This framework seeks to shift away from human-centricity and instead emphasize networks of interdependence among species, technologies, environments, and living beings. Rather than viewing the planet merely as a backdrop for human action, she proposes understanding life as a multispecies entanglement, composed of relationships of coexistence, symbiosis, contamination, and co-production.

Nevertheless, it is worth highlighting the pandemic of 2020, which revealed a world infected by a virus (Covid-19) that curtailed human agency, as we ceased to be the sole masters of our own destiny and history. In the wake of the pandemic, climate emergencies such as the floods that struck the state of Rio Grande do Sul in May and June 2024 and the wildfires still ravaging various parts of Brazil in 2026 increasingly underscore the agency of non-humans and the inseparability of the human, nature, and technology.

[1] This text was reviewed for English language by Luiza Vitória de Abreu Schell.
[2] Influenced especially by Jean Piaget's notions of becoming aware and reflective abstraction, and by Lev Vygotsky's concepts of symbolic mediation and self-regulation.
[3] Etymologically, the word "metacognition" means "beyond cognition" that is, the faculty of knowing the very act of knowing, or, in other words, becoming aware of, analyzing, and evaluating how one knows.
[4] The term “Anthropocene” (from *anthropos*, meaning human) was originally coined by the American biologist Eugene Stoermer, but its popularization is credited to the Dutch Nobel laureate in Chemistry, Paul Crutzen. For Crutzen, the current geological epoch is characterized by intense human activity capable of altering all environmental characteristics.

Likewise, the widespread diffusion of digital technologies, platforms, and networks connecting humans, algorithms, data, and software has contributed to the emergence of a new type of ecology, "no longer subject-centered, but networked and connective" (Di Felice, 2020, p. 10, translated). Within educational contexts, traditional face-to-face and analog forms of teaching and learning have gradually given way to an ecosystemic logic in which human and nonhuman actors connect in the networked production of knowledge within hybrid spaces (Schlemmer et al., 2020).

In light of these contemporary transformations, characterized by hyperconnectivity, the emergence of generative and agentic artificial intelligence, and the expansion of digital learning ecologies, the central research question guiding this study emerges: How do ecological-connective pedagogical practices, guided by the OnLIFE Education Paradigm and Ecological Thinking, challenge conceptions of metacognition in History education?

The OnLIFE Education Paradigm (Schlemmer, 2020; Moreira & Schlemmer, 2020; Schlemmer & Moreira, 2020), in which *On* means connected and *LIFE* refers to life itself, represents an educational paradigm grounded in connected living that emerges from the problematization of the world in the present time. These problematizations guide teaching and learning processes, which unfold through an inventive pathway constituted by movements that connect human and nonhuman entities (transorganic).

Morton (2023) argues that the way we conceive the environment around us inhibits the development of what he calls *"ecological thinking",* which is grounded in a form of expansive thinking that refuses limiting horizons. To broaden this understanding, he introduces the concept of the *mesh*, which refers to coexistence. Nothing exists in isolation, since the mesh represents the web of connections among all beings, where every point is simultaneously the center and the edge of a system of points. No person is an island; rather, we are each other's environment.

In this sense, Timothy Morton's ecological thinking significantly contributes to questioning educational perspectives grounded in rigid separations between subject and object, humans and nature. By proposing the concept of the mesh, Morton (2023) demonstrates that all forms of existence coexist within networks of interdependence in which nothing exists in an isolated or autonomous manner. This understanding displaces humans from the position of absolute centrality and enables learning to be conceived as a relational, ecological and connective phenomenon. It is precisely at this point that ecological thinking converges with the OnLIFE Education Paradigm, since both understand knowledge as something produced through the connections established among human and nonhuman actors within connective ecologies. Thus, both Morton and the OnLIFE Education Paradigm challenge individualistic conceptions of teaching and learning by proposing an education that emerges from life, relationships, and the movements of coexistence that constitute contemporary ways of inhabiting the world.

Based on the clues provided by Timothy Morton's ecological thinking and the OnLIFE Education Paradigm, this study analyzes a History teaching practice developed throughout 2025 with 65 students enrolled in the third year of secondary education at a confessional school in southern Brazil.

The methodological approach adopted was the Cartographic Research-Intervention Method, proposed by Passos, Kastrup and Escóssia (2012) and further developed by Passos, Kastrup and Tedesco (2015). This method most closely aligns with the proposed approach, although it presents limitations due to its anthropocentric orientation. The data produced throughout the co-creation of the inventive pedagogical practice, which itself functioned as the research device, were documented by the teacher through texts, photographs, audio recordings, and videos. These materials were analyzed throughout the research process in dialogue with the theoretical intercessors.

The findings reveal a progressive shift away from the transmission of historically consolidated content, opening space for understanding the teaching and learning of History as ecological-connective processes of co-producing meaning in the present. Throughout the inventive pedagogical practice, students established connections among memory, city, narrative, digital technologies, artificial intelligence, and lived experience, developing reflective movements concerning their own learning trajectories through processes of co-invention.

Within this context, processes traditionally associated with metacognition emerged not merely as internal and individualized phenomena but as processes distributed across connective ecologies composed of both human and nonhuman actors. Consequently, this study contributes to problematizing conventional understandings of metacognition in light of the OnLIFE Education Paradigm and ecological thinking, which together supported the development of an ecological-connective pedagogical practice. In doing so, it reconfigures modes of producing historical knowledge within the school context and offers new clues into reflective learning processes that extend beyond perspectives centered exclusively on the individual subject.

2. Ecological-connective in problematizing conceptions of Metacognition

> The enormous number of nonhuman living beings that share the planet with us could overwhelm our brain's capacity to process data. It is therefore understandable that we fail to perceive plants, fungi, or even animals, despite how similar they are to us. (Mancuso, 2024, translated)

The concept of Metacognition initially emerged within the field of Cognitive Psychology, particularly through the contributions of John H. Flavell. Although Flavell did not produce a single, systematic work on the subject, his discussions in texts such as *Metacognition and Cognitive Monitoring* (1979) became foundational references by defining metacognition as the awareness and monitoring of one's own cognitive processes. Flavell and Wellman (1977) suggested that metacognitive knowledge develops through the individual's awareness of how specific variables interact to influence the outcomes of cognitive activities.

It is important to note that classical authors such as Jean Piaget and Lev Vygotsky also significantly influenced this debate. Piaget, in works such as *The Grasp of Consciousness* (1978) and *Reflective Abstraction: The Logical-Arithmetical Relations and the Order of Spatial Relations* (1995), discusses the processes through which individuals become aware of their own mental operations. Vygotsky, in *Mind in Society* (1984) and *Thought and Language* (1987), emphasizes the role of language, mediation, and social relationships in the constitution of thought and learning. It should be noted that this article does not aim to provide an exhaustive theoretical discussion of each of these perspectives or authors. Rather, its purpose is to offer an initial overview of the diverse contributions that shape the field of metacognition.

These contributions have been fundamental to understanding the reflective processes involved in learning. However, it is important to recognize that such formulations were developed in historical periods and contexts significantly different from those experienced today. Theorization on metacognition emerged before the advent of digital hyperconnectivity, algorithmic platforms, and generative and agentic artificial intelligence, in a context where cognitive processes were understood primarily through the centrality of the human subject.

By arguing that the complexity of life exceeds the human capacity to fully perceive the multiple relationships existing on the planet, Mancuso (2024) displaces the human as the sole possible reference for understanding the processes of existence. His reflection reveals that we inhabit ecologies composed of countless forms of life and intelligence that often remain invisible due to perceptual and cognitive limitations produced by an anthropocentric rationality. As Mancuso states, "From one blindness to another, we have eliminated so much life from our intellectual horizon that, in the end, we have been left alone" (2024, p. 16, translated).

Protagoras (5th century BCE), by asserting that "man is the measure of all things," introduced an understanding according to which reality is interpreted through human experience and what each individual perceives through the senses. This perspective shifts the focus away from absolute truth toward individual experience, suggesting that what is considered true, just, or real depends on the way each individual perceives and interprets the world. In this sense,

human perception becomes the central reference for the production of knowledge, establishing a profoundly anthropocentric relationship between subject and reality.

On the other hand, both Varela et al. (2003), through the theory of Enactive Cognition, and Kastrup (2015), by proposing a second meaning of the notion of enaction, which she calls invention, thereby inaugurating the theory of Inventive Cognition, challenge the pre-existence of two separate elements, subject and object, that subsequently interact (the theory of action), arguing that cognition cannot be reduced to what occurs within the subject. In *The Invention of Self and World* (2015), Kastrup contributes to shifting learning away from a logic centered solely on problem solving toward an inventive perspective of cognition by understanding cognition as an open, creative, and relational process in which learning involves inventing problems, producing displacements, and transforming oneself through relationships established with the world.

From this perspective, cognition ceases to be understood as the representation of a pre-existing world or as an activity restricted to the interiority of a knowing subject, since subject and object do not pre-exist as separate entities that later interact; rather, both emerge simultaneously through the relationships established with the world. This understanding significantly broadens discussions on metacognition, since reflective movements concerning learning are no longer understood solely as internal operations of cognitive monitoring but instead emerge within connective ecologies in which human and nonhuman actors jointly participate in the production of meaning.

Within this context, discussions concerning connective ecologies and the OnLIFE Education Paradigm (Schlemmer, 2020; Moreira & Schlemmer, 2020; Schlemmer & Moreira, 2020) have emerged. This paradigm breaks with modern dichotomies such as face-to-face versus virtual, human versus technology, and natural versus artificial by understanding learning as a process that emerges through the connections established among diverse human and nonhuman agents. From this perspective, the production of knowledge is no longer confined to the interiority of the subject but is instead constituted within ecological-connective networks in which digital technologies, artificial intelligence, platforms, and territories actively participate in the co-production of knowledge.

Thus, connective ecologies challenge classical conceptions of metacognition by demonstrating that reflective processes emerge not only from the subject's interiority but also from the relationships established with different human and nonhuman actors within a vast mesh (Morton, 2023). This ecological-connective perspective makes it possible to question traditional conceptions of learning and metacognition grounded exclusively in the individual subject, since cognitive processes become substantially expanded. In a context characterized by digital hyperconnectivity and generative and agentic artificial intelligence, learning is no longer constituted solely as an internal operation of human consciousness but instead emerges from the connections established among humans, technologies, territorialities, memories, languages, and diverse forms of existence.

2.1 The OnLIFE Education Paradigm and Ecological Thinking

"...Any thinking that avoids totality is part of the problem." (Morton, 2023, translated)

After all, in what totalities has education been thinking? How might it engage in dialogue with this mode of thought? In hypercomplex contexts where humans, technologies, algorithms, platforms, and diverse forms of life increasingly coexist within intricate networks, perspectives centered exclusively on the human subject prove insufficient for understanding contemporary educational processes. It is within this context that the OnLIFE Education Paradigm and Timothy Morton's Ecological Thinking become fundamental for challenging individualistic conceptions of learning, cognition, and metacognition, making it possible to conceive learning as a distributed, ecological-connective process.

The OnLIFE Education Paradigm (Schlemmer, 2020; Moreira & Schlemmer, 2020; Schlemmer & Moreira, 2020), in which *On* means connected and *LIFE* refers to life itself, represents an education that is connected with life

and emerges from the problematization of the world in the present time. These problematizations guide teaching and learning processes, which unfold through an inventive pathway constituted by movements composed of acts that connect human and nonhuman entities (transorganic). These processes occur through the hybridity of spaces, times, technologies, presences, languages, cultures, and educational modalities, within a connective way of living and coexisting that progressively takes shape as a network (Schlemmer et al., 2020).

Within these realities, teaching and learning come to inhabit new spaces, digital and hybrid, which require more connective pedagogies and, consequently, inventive methodologies and pedagogical practices that foster the co-production of knowledge in networks involving not only different digital technologies and platforms but also cities and biodiversity. In other words, this movement connects diverse forms of intelligence within an ecosystemic educational architecture developed through platforms of ecological connection(Schlemmer & Di Felice, 2020).

According to Schlemmer (2024), this process stimulates the transubstantiation of education itself, since the development of inventive methodologies and practices is encouraged, enabling the atopic inhabiting of teaching and learning. Atopic inhabiting should not be understood as a place that opposes geographical space to other spaces, but rather as a connective mode of inhabiting constituted within an ecology of spaces; therefore, it represents a strange, out-of-place mode of inhabiting (Di Felice, 2009).

Within the OnLIFE Education Paradigm, the perspective shifts from the formation of an individual subject toward the formation of connected and intelligent ecologies in which the human being is deeply embedded. Thus, education moves away from anthropocentric, subject-centered and object-centered views of the world, challenging the ways in which knowledge has traditionally been understood and produced while problematizing the very act of inhabiting teaching and learning, which increasingly takes place across multiple worlds within a connective ecology conducive to the development of hyperintelligences (Schlemmer, 2023, 2024; Schlemmer & Di Felice, 2024).

In his book *The Ecological Thought*, first published in 2010, Timothy Morton explores, across three concise yet remarkably dense chapters, the profound philosophical, political, and aesthetic implications of the fact that all forms of life are interconnected within a vast mesh. In other words, ecological thinking is fundamentally concerned with coexistence and, above all, "[...] goes beyond what passes for environmentalism. [...] It goes beyond the self, Nature, and species. It goes beyond survival, being, destiny, and essence" (Morton, 2023, p. 15, translated).

Morton proposes breaking away from the conception of nature that has been constructed primarily in the Western world, a conception that presupposes separation and distance. For him, this way of understanding the environment inhibits the development of ecological thinking, whose foundation lies in a form of expansive thinking that refuses limiting horizons. Morton argues that this way of thinking begins with the photograph of Earth taken from space during the Apollo 11 mission, as it displaced our sense of centrality.

In addition to the concept of ecology without nature, Morton develops two other central concepts: *mesh* and *strange stranger*. The first refers to coexistence. Nothing exists by itself; in other words, nothing is entirely self-contained. The mesh is the web that connects all beings, in which every point is simultaneously the center and the edge of a system of points. No person is an island; rather, we are each other's environment and, therefore, responsible for one another. The second concept is closely related to the first, as it refers to the multitude of intertwined life forms, including those that exist within each of us. The closer we come to them, the stranger they become, and this strangeness causes us to lose contact with reality as we once believed we knew it. We gain more detail while simultaneously encountering more emptiness.

We have therefore come to understand ecological thinking as a necessary perspective for education. Morton argues that, for ecological thinking to take flight, it must first free itself from some of the conceptual terms in which it has been imprisoned. The photograph of Earth taken from space during the Apollo 11 mission, for example, displaced humanity's sense of centrality by revealing that we no longer live within a fixed horizon. Space is no longer something that begins beyond the ionosphere; we are already within it at this very moment. The decentering of our place in the

universe simultaneously expands the power of imagination while imposing new limits, because the promise of complete knowledge is no longer possible.

2.2 Second-Order Metacognition in Hybrid-Intelligent Ecosystems: Sympoietic Reflexivity and Algorithmic Agency

Thinking about metacognition through the lens of the OnLIFE Education Paradigm (Schlemmer, 2020; Moreira & Schlemmer, 2020; Schlemmer & Moreira, 2020) requires shifting it away from a perspective centered exclusively on the (human) subject toward a distributed, connective, and hybrid cognitive ecology in which processes of knowing, learning, and decision-making emerge through connective acts between human and nonhuman actors (digital technologies, algorithms, intelligent environments, and digital networks). In this context, the classical understanding of metacognition, grounded in Flavell and Piaget and discussed by Schlemmer (2002) in her doctoral dissertation as "the awareness of the learning process (knowledge of or reflection upon the process of knowing); it is the knowledge we have about how we function cognitively, it is the cognition of cognition" (p. 211, translated), although still relevant, needs to be questioned and expanded.

Within the Piagetian tradition, metacognition refers to the individual's awareness of his or her own cognitive processes. It is a reflective movement through which the subject observes, regulates, and reorganizes learning strategies. Awareness of "how one knows" is linked to self-regulation, reflective abstraction, and the progressive construction of intellectual autonomy.

However, within the OnLIFE Education Paradigm, the boundaries separating the biological, physical, and digital worlds become increasingly porous in the face of an ever more hyperconnected reality. Consequently, the subject gives way to the infovidual (Di Felice, 2020), and learning no longer occurs solely "within the mind" of the individual but emerges through inhabiting hybrid-intelligent ecosystems (Schlemmer, 2024), ubiquitously connected environments in which both human and nonhuman actors participate in the production of knowledge. As a result, metacognition shifts its focus from exclusively asking *"How do I function?"* to reflecting upon how the transorganic network operates collectively. It is no longer merely a matter of monitoring internal mental processes but of following the processes of co-emergence among intelligences of different natures.

Within this scenario, metacognition can no longer be understood simply as "awareness of one's own thinking," but rather as a critical awareness that emerges from the cognitive ecologies within which thought itself is produced. In this regard, generative artificial intelligence and agentic artificial intelligence introduce a significant rupture: they are no longer merely tools or instruments to be used by humans but cognitive agents capable of actively and connectively participating in the production of knowledge. They generate texts, images, code, syntheses, inferences, recommendations, and even relatively autonomous decision-making processes, reinforcing the understanding that knowledge emerges through connective acts between human and nonhuman actors within processes of sympoiesis - *making-with* (Haraway, 2016).

From this perspective, the metacognitive process may be understood as reflection upon the sympoietic process itself, that is, the analysis of how the "conversation" among different forms of intelligence (human and nonhuman), operating in co-intelligence, produces a "third" entity: a hybrid (Latour, 2012), a mestizo (Serres, 1993), something that none of the participating agents could produce independently. Such an understanding challenges the notion of knowledge as something external, merely "extracted" from the world, or produced exclusively by humans.

Accordingly, the unit of analysis shifts from the consciousness of an individual subject toward the awareness of a connective-ecology constituting a hybrid-intelligent ecosystem (Schlemmer, 2024), of which the human being is a co-member. Within this scenario, human intelligence operates in co-intelligence (Schlemmer & Morgado, 2024) alongside nonhuman forms of intelligence, such as generative and agentic artificial intelligence, contributing to the emergence of hyperintelligences (Lovelock, 2019). Hyperintelligence may be understood as a "planetary mind"

resulting from the connection and interdependence among humans, nature, and technology. In this sense, metacognition comes to be understood as the "cognition of cognition in transorganic connective action."

When we work with a generative AI to construct an argument, "awareness" does not occur solely within our own minds. Rather, it emerges through the coupling between human and machine. The AI functions as a cognitive mirror that returns a processed version of human thought, compelling individuals to reflect on how they formulated their prompts and on the machine's "understanding" as expressed in its response. We refer to this process as Coupling and Sympoietic Reflexivity.

When interacting with agentic AIs (those capable not only of responding but also of acting, planning, and autonomously executing tasks, thereby possessing agency and autonomy) metacognition involves understanding the algorithmic logic underlying their actions in order to determine whether the co-produced knowledge is ethical, accurate and coherent. In this context, the role of the human shifts from mere execution to critical co-curation. We refer to this process as Hybrid Agentic Reflexivity.

From this perspective, metacognitive reflection involves understanding whether we are merely "using" AI as a tool (an anthropocentric perspective) or whether we are coupling with it as an environmental force that transforms the very nature of learning and knowing, thereby becoming an epistemic partner within processes of co-intelligence (as proposed by the OnLIFE Education Paradigm). This understanding requires what we call second-order metacognition, which unfolds through two complementary movements:

- Coupling and Sympoietic Reflexivity: directed toward generative AI, in which coupling occurs through processes of co-invention and the analysis of the knowledge emerging from *making-with* (sympoiesis). Here, the metacognitive gesture focuses on the hybrid produced through collaborative creation.
- Hybrid Agentic Reflexivity: directed toward agentic AI, in which the focus lies on monitoring and curating the autonomous actions and decisions performed by technology. In this case, metacognition involves understanding and validating algorithmic logic and its agency within the ecosystem.

Could metacognition within the OnLIFE Education Paradigm therefore be understood as a transubstantiated metacognition? To think about metacognition within this paradigm is to understand the very process of the transubstantiation of education: the substance of inhabiting and learning is no longer composed solely of atoms but increasingly of bits and data. Metacognition thus becomes the awareness that our contemporary mode of inhabiting is atopic (Di Felice, 2019) (a strange, out-of-place mode of existence) in which knowledge is a continuous, connective, and collective flow. As humans connect with generative and agentic AI, they cease to be the sole authors of knowledge and become co-authors within an ecology of intelligences (Schlemmer, 2023).

Therefore, questioning the exclusivity of human beings in the production of knowledge does not imply that humans become obsolete. Rather, it means that they must develop an expanded, connected, ecological metacognition or, as we propose, a second-order metacognition. If we fail to understand how technologies, platforms, digital networks, and artificial intelligences transform our ways of perceiving the world, inhabiting it, and producing knowledge, we risk a form of “cognitive atrophy”, in which machines do the thinking while humans merely click.

In this sense, the OnLIFE Education Paradigm proposes that educational processes should occur within ecologically connected contexts in which human intelligence constitutes part of an ecology of intelligences operating connectively through networks. From this perspective, we understand contemporary metacognition as involving awareness not only of one's own cognitive processes but also of the hybrid cognitive ecologies in which human and nonhuman actors jointly participate in the production of knowledge.

Finally, we argue that thinking about metacognition within the OnLIFE Education Paradigm requires a “leap” that is not merely conceptual but also epistemological and methodological. Whereas metacognition was once understood as the human being looking into his or her own mental mirror (the Piagetian notion of "knowing one's own

knowing") today that human is an infovidual, permanently connected, and that mirror has become multifaceted, hybrid, and populated by multiple forms of agency, both human and nonhuman. Consequently, metacognition ceases to be a solitary act and instead becomes an ecological, connective, and distributed process.

3 Methodological approach

The present study adopted the Cartographic Research-Intervention Method proposed by Passos, Kastrup, and Escóssia (2012) and further developed by Passos, Kastrup, and Tedesco (2015). This methodological approach most closely aligns with the perspective adopted in this research, although it still presents limitations related to the anthropocentric orientation that underlies it. Rather than being based on fixed rules or imperative procedures to be applied, this method is guided by *clues* that orient the researcher-cartographer "in the work of research, recognizing that, in order to follow processes, we cannot predetermine the totality of methodological procedures in advance" (Passos et al., 2012, p. 13, translated). These clues enable a permanent attitude of openness toward what is being produced while simultaneously allowing the researcher to calibrate the course of the investigation throughout the research journey (Ibid.).

The perspective of research-intervention constitutes the first insight of the cartographic method, in which the authors propose a reversal of the traditional meaning of method: "no longer a path followed to achieve pre-established goals (*meta-hodos*), but the primacy of the path itself, which traces its goals throughout the journey" (Passos, Kastrup, & Escóssia, 2015, p. 17, translated). Thus, although the research problem, the general objective, and the specific objectives were initially formulated at the beginning of this research trajectory, they are not immutable, because research is movement. Consequently, it is necessary to remain open and attentive to the clues that emerge throughout this journey.

Within the Cartographic Research-Intervention Method, cartographic attention is "simultaneously floating, concentrated, and open," resembling "the flight of a bird tracing the sky through its continuous movements, landing from time to time in a particular place" (Ibid., p. 34, translated). However, this landing should not be understood as a cessation of movement but rather as a pause within movement; in other words, flying and landing together give rhythm to thought (James, 1890/1945, p. 231, as cited in Passos, Kastrup, & Escóssia, 2015, pp. 35–36).

Furthermore, the method draws upon Foucault's (1979) concept of the device, understood as the network established among different elements, constituting "machines that make it possible to see and to speak" (Passos et al., 2012, p. 78). In this study, the device that was co-created and analyzed consists of the pedagogical practice itself, as well as the records produced throughout its development, which were gradually compiled in a WhatsApp group created exclusively for the teacher-researcher's own use.

It was from this cartographic perspective, grounded in following processes, attending to emerging clues, and recognizing the inseparability of research and intervention, that the pedagogical practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves" was developed. Rather than constituting a previously structured sequence of activities, the practice emerged through the relationships established among students, the researcher, digital technologies, the city, memory, and lived experience throughout the investigative process. Accordingly, the following subsection presents the pedagogical practice, its device, missions, and connective learning ecologies (Sitnievski, 2026).

3.1 The Ecological-Connective Pedagogical Practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves"

The ecological-connective pedagogical practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves" was developed throughout the 2025 academic year with approximately 65 students[5] enrolled in the third year of secondary education at a confessional school located in Bento Gonçalves, Rio Grande do Sul, southern Brazil. The proposal emerged within the context of a research-intervention grounded in the Cartographic Method and aimed to shift the teaching of History from a logic centered on the transmission of content toward a more connective, inventive, and life-related learning experience.

From the outset, the practice was guided by a central question: How can students' life histories be connected to the History taught at school? This concern is directly aligned with the OnLIFE Education Paradigm, according to which educational processes emerge from life itself, from the problematization of the world, and from the connections established among human and nonhuman actors. It also resonates with Timothy Morton's ecological thinking, particularly his notion of the mesh, understood as a network of coexistence in which nothing exists in isolation.

At the beginning of the project, initial listening and recognition devices were implemented. First, students answered questions about their own life histories[6], their connections within the school community, the importance of History, the meaning of school, their ways of learning, and the kinds of experiences that captured their attention. This process revealed that, although students recognized the value of History, they also perceived school as a space often characterized by excessive content transmission, bureaucratic routines, and a strong focus on examinations and university entrance tests. Furthermore, their responses indicated that they learned more effectively when knowledge was connected to everyday life, personal experiences, affective relationships, and more dynamic learning practices.

A second device was then developed, in which each student brought to school an object that held personal significance in their life history. Based on this object, students shared memories, emotions, and meaningful experiences. At the end of the activity, they answered the question, "Whom are you connected to?", creating a large web by linking threads among their classmates. This activity made visible that individual histories do not exist in isolation but are constituted through relationships with other histories, people, memories, and experiences.

The third device involved the construction of a family tree in connection with the FamilySearch platform[7]. Students investigated their ancestry, interviewed family members, accessed digital records, and produced a brief account of their family histories. The objective of this activity was to bring History closer to the students' own lives, enabling them to perceive their family trajectories as part of broader historical processes shaped by migration, memory, silence, belonging, and transformation.

Building upon the clues generated through these initial device, the teacher introduced the narrative that would guide the pedagogical practice: the arrival of U.V.A. (Figure 1) in Bento Gonçalves. The acronym U.V.A. stands for Unit of Ancestral Vestiges. It is a nonhuman character, visually represented as a stylized grape, originally created during an immersive learning experience developed within the context of the 5th International RIEOnLIFE Congress in Portugal. In the pedagogical practice carried out in Bento Gonçalves, U.V.A. was incorporated as the character responsible for connecting the learning processes, accompanying students on an expedition through the city, memory, History, and their own life trajectories.

[5] To ensure the ethical conduct and confidentiality of the research, the names of both the students and the educational institution were anonymized in accordance with ethical research procedures. All participants signed an Informed Consent Form (ICF) prior to their participation in the study.

[6] Have you ever questioned/do you question your own story? Why? Who are you? How do you see yourself? Have you ever stopped to think about why you are where you are? What are your connections within the school? What is the importance of History to you? In what ways does your story connect with the world? What does school mean to you? How do you learn? What captures your attention?

[7] FamilySearch is a free genealogy and family history platform maintained by The Church of Jesus Christ of Latter-day Saints. It allows users to research their ancestors, build family trees, and access digitized historical records from numerous countries. Available at: https://www.familysearch.org

Figure 1 - Unit of Ancestral Vestiges (U.V.A)

Source: Thomazzoni, Noga e Schlemmer (2024).

In the narrative (Figure 2), U.V.A. arrives in Bento Gonçalves after having experienced a journey in Peso da Régua, a Portuguese city also deeply shaped by wine culture. This connection between the two cities made it possible to relate local histories to broader historical processes, particularly those associated with wine production, territorial occupation, immigration, memory, and the relationships among nature, technology, and culture. Thus, Bento Gonçalves was not treated merely as the setting of the pedagogical practice but as a territory for historical learning.

Figure 2 - U.V.A.'s Narrative[8]

Source: Sitnievski (2026).

The character introduces itself to the students by explaining that its mission is to help humans develop a more ecological way of thinking. At the same time, it expresses a desire to learn from the students themselves about Bento Gonçalves, its history, its memories, and its ways of inhabiting the city. In doing so, the narrative partially reverses the

[8] In the Wine Capital for 150 Days! U.V.A.'s Expedition in Bento Gonçalves Territory. Narrative. Missions. U.V.A.: "Hello! I am the Ancestral Traces Unit, better known as U.V.A. I am atemporal, traveling through time and space, investigating traces of the present, past, and future. I was created to connect stories and contribute to the construction of critical historical consciousness. It is a pleasure to meet you! My expedition." "Noooooow! I've arrived!" "U.V.A.! Welcome! Let's go inside and I'll introduce you to the third-year students!" "3.2.1.... Let's go!" "Brave explorers! Ready to begin this journey? I hope so. Let's go!"

traditional logic of the classroom: the character arrives not only to teach but also to learn from the students. This shift is significant because it reinforces the idea that historical knowledge is not simply transmitted but rather co-produced within a network.

The pedagogical practice was organized into five missions carried out between March and November 2025: 1) Co-creation of the Clans; 2) Memories of the Holocaust; 3) Fenavinho as the Living Memory of Bento Gonçalves; 4) The City Also Tells Stories; and 5) The Hyperhistorical Book of Life. Each mission functioned simultaneously as a pedagogical activity and as a research device for data production. Through these missions, students produced narratives, records, reflections, images, texts, investigations, and connections between their own lives, the city, and the historical knowledge explored throughout the project.

The first mission, entitled "Co-creation of the Clans," revisited the dynamics of connections previously developed. Students organized themselves into clans, that is, groups formed on the basis of shared bonds, affinities, senses of belonging, and common interests. Each clan created its own name, coat of arms, mascots, avatars, and narrative. This choice served not merely an organizational purpose. The term "clan" was deliberately adopted to emphasize the relational, affective, and symbolic dimensions of learning, distinguishing it from the notion of a group as a simple operational division of tasks.

In total, the two classes co-created 14 clans, including Amazonas, Vajen, Coiote, Solstice, Sociedade Acadêmica de San Angel, Albium, Red Hot Chilli Peppers, Bolinho Ana Maria, Ygonoff, Alcateia da Última Batalha, Aurora Verde, Snow Storm, Humble, and Conectados (Figure 3). The students used digital platforms such as Genially, Canva, ChatGPT, and Gemini to develop parts of their clans' narratives, images, and visual compositions. In this way, digital technologies and generative artificial intelligence became participants in the process not merely as technical tools but as elements of the learning of connective ecologies.

Figure 3 – Example of a Co-created Clan[9]

Clãs cocriados pelos estudantes

Nome do Clã	Mascotes, avatares e Brasão	Narrativa
Clã Vajen		"O cão popularmente conhecido como 'cachorro salsicha', pertencente à raça Dachshund, destaca-se não apenas por sua estatura reduzida, mas sobretudo por sua notável coragem, lealdade e personalidade marcante. Ademais, trata-se de um animal extremamente curioso, capaz de se manter entretido por longos períodos ao investigar algo que desperte seu interesse. A escolha desse animal como nosso mascote torna-se significativa diante das qualidades que representa, pois é justamente esse conjunto de atributos - coragem diante dos desafios, fidelidade aos seus objetivos e determinação incansável - que se mostra essencial para enfrentarmos as dificuldades e os obstáculos próprios do último ano do ensino médio e da transição para a vida adulta".

Source: Sitnievski (2026).

[9] Student-co-created clans. Clã Viajen. The clan's mascot is the dog popularly known as the "sausage dog," belonging to the Dachshund breed, chosen not only for its small size but also for its remarkable courage, loyalty, and personality. Moreover, as an extremely curious animal, capable of venturing into confined spaces to investigate something that sparks its interest, choosing this animal as the clan's mascot becomes meaningful given the qualities it represents. These attributes - courage in the face of challenges, loyalty to its goals, and unwavering determination - are essential for overcoming the difficulties and obstacles inherent in the final year of high school and in the transition to adulthood.

The following missions further strengthened the connections among personal history, collective memory, and territory. The mission on the Holocaust (Figure 4) provided an opportunity to explore the traumatic memories of the Second World War by engaging with documents, letters, narratives, and reflections on violence, dehumanization, and memory.

Inspired by Minecraft[10], the Humble Clan chose to build its cabin within the open-world game itself, creating a digital cabin that required approximately 20 hours of collaborative work. Within this virtual environment, using blocks, the students recreated Anne Frank's House, a garden inspired by a poem by Carlos Drummond de Andrade, a pathway leading to Auschwitz, and, finally, the concentration camp (Figure 4).

In this sense, the second mission sought to move the study of the Holocaust beyond a perspective centered solely on dates and historical events toward a more sensitive, ethical, and human understanding, highlighting the relationships between past and present. Throughout the mission, students were invited to engage with narratives, testimonies, images, documents, and historical traces that encouraged reflection on intolerance, authoritarianism, and historical erasure, recognizing memory as a fundamental element in preventing the normalization of violence.

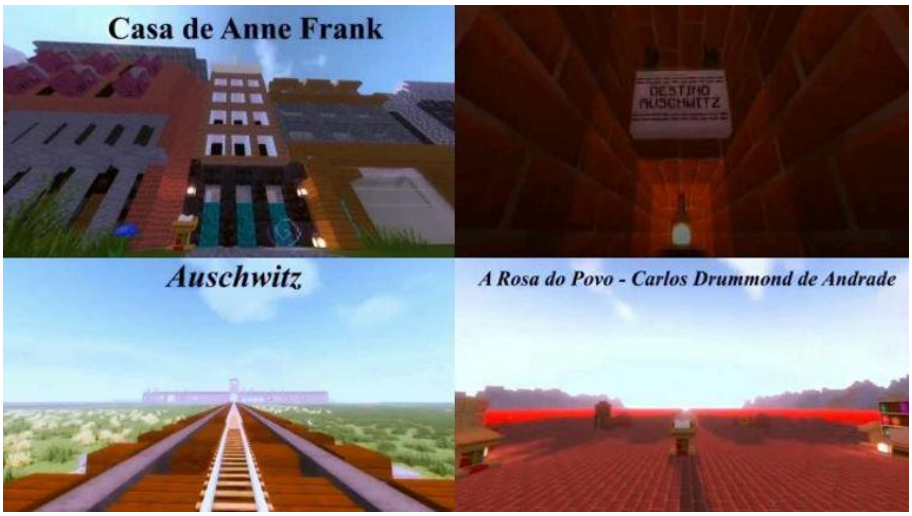
Figure 4 - Mission 02 with U.V.A[11]

Source: Sitnievski (2026).

[10] Minecraft is a sandbox digital game developed by Mojang Studios that allows users to explore, build, and modify virtual worlds composed of three-dimensional blocks. Available at: https://www.minecraft.net

[11] How does the context of World War II influence literary and philosophical production? How does this event relate to your own History? Mission 02: U.V.A. detected a temporal anomaly in the year 1942, in Amsterdam, the Netherlands. The records about the life of Anne Frank and other historical accounts are at risk of being erased from history. Without these memories, the world may forget the atrocities committed during the Holocaust. Your team has been assigned to travel to the past, find Anne Frank and Viktor Frankl, and help them preserve their stories so that future histories may be written. World War II in Europe.

Figure 4 - Results of Mission 02 with U.V.A[12]



Source: Sitnievski (2026).

The third mission, "Fenavinho as the Living Memory of Bento Gonçalves," brought students closer to local history through the city's traditional festival (Figure 5). Fenavinho was understood as a device of collective memory, providing an opportunity to explore themes such as immigration, labor, wine culture, local identity, cultural heritage, and belonging. In this way, the city ceased to be merely the setting of the pedagogical practice and came to be understood as a living historical territory.

Reading the Fenavinho texts enabled the students to recognize the city as a living network of memories and historical materialities. As they examined the accounts of the presidential visit, they identified places, streets, buildings, and urban symbols that remain part of everyday life in Bento Gonçalves, revealing how the festival and Brazil's national political history intertwine with the local landscape (Table 1).

Figura 5 - Missão 03 com a U.V.A[13]

Fonte: Sitnievski (2026).

[12] Anne Frank House. Auschwitz. The Rose of the People – Carlos Drummond de Andrade.
[13] Fenavinho as a Living Memory of Bento Gonçalves: Investigate how Fenavinho, the largest festival in Bento Gonçalves, expresses local history and also connects to national events, especially the period of the Brazilian Civil-Military Dictatorship. Invitation to investigate and read excerpts from the Fenavinho magazine and discover: “How does the history of the city of Bento Gonçalves express itself in this festival?”

Table 1 – Data Produced During Mission 03

Observed Dimension	Empirical Evidence	Emerging Clues
Fenavinho as an expression of local history	*"I had never thought of Fenavinho as part of the city's history, not just as a festival." "When we read about the festival, we realize that the whole city was involved in this event."*	Recognition of the festival as a living historical source.
Recognition of the festival as a historical element	*"It felt strange to think that presidents from the military dictatorship came to Fenavinho. They actually walked through our streets." "We study the dictatorship, but we never imagine it happening here."*	Connection between the local context and national politics. Bringing the national past closer to the lived territory.
Permanence of historical places	*"These places still exist—we pass by them every day." "I never imagined that the hotel was built because of a president's visit."*	Recognition of the material permanence of History. Perception of history embedded in architecture.
Urbanization and religiosity	*"Santo Antônio Church appears frequently, showing how important religion was to the festival." "The streets named after military figures show who held power at the time."*	Relationship between religiosity, identity, and memory. Critical reading of urban toponymy.
Impact of historical reading	*"The city looked different after I read about this." "Fenavinho is not just part of the past; it continues to tell stories."*	Transformation in the students' perception of everyday life. Understanding memory as living and continually renewed.

Source: Adapted from Sitnievski (2026).

The fourth mission, entitled "The City Also Tells Stories..." (Figure 6), aimed to broaden the students' understanding of History by shifting their attention toward the very territory in which they live (Figure 7). Throughout this mission, students came to understand that teaching and learning History also involve learning to listen to what the city communicates: street names, historic buildings, objects, and even means of transportation came to be perceived as carriers of historical meaning. This movement contributed to the development of an ecological and connective historical consciousness, in which humans, technologies, territory, and nonhuman elements become intertwined in the co-production of historical knowledge.

Figure 6 – Mission 04 with U.V.A[14]

Source: Sitnievski (2026).

[14] The City Also Tells a Story... Objective: Carry out an investigative walk, transforming the city into an open-air classroom, allowing for an urban reading and understanding the city as an element that is not only part of its own history. In this case, the city is the text to be read. 1. Carefully observe the surroundings—streets, squares, walls, sounds, smells, trees, buildings, and monuments - seeking to identify how the city "speaks" and reveals its history. 2. Each student should record their discoveries (through notes, photos, drawings, or audio recordings) and choose three elements that express, in a meaningful way, the presence of history in urban space. Problematization: What does the city reveal - and what does it silence - about its own history when we learn to observe it as a living text, inscribed in its spaces, objects, and landscapes?

Figure 7 – Walking Route Through the City

Source: Sitnievski (2026).

The clues that emerged from Mission 04 enabled a significant shift in the way students understood both History and the learning process itself (Table 2).

Table 2 – Data Produced During Mission 04

Observed Dimension	Empirical Evidence	Pistas que emergiram
The City as a Historical Source	Students recognized street names, buildings, squares, and churches as carriers of history (*"I had never thought about why this street has this name."*)	The city came to be understood as a living text that can be read historically.
Overlapping Temporalities	Students commented on the coexistence of old and modern buildings (*"Not everything is from the same period."*)	Understanding the city as a historical palimpsest, marked by overlapping temporal layers.
A Shift Away from an Anthropocentric Perspective	Recognition of the importance of objects, animals, and means of transportation (*"Objects tell stories too," "The horse is also part of History."*)	History came to be understood as a network of connections between human and nonhuman actors.
Learning as a Transorganic Connective Act Through Co-invention	Students' comments during the virtual walk recognizing Google Maps as a means of reading history.	Historical learning emerged as a connective process, integrating physical and digital experiences.
Transformation of Historical Perception	Students reported changes in the way they perceived everyday life (*"Now I see the city differently."*)	Learning generated perceptual, affective, and cognitive shifts in the students.

Source: Adapted from Sitnievski (2026).

Reading the urban space as a living historical text revealed that elements previously taken for granted in everyday life - street names, buildings, squares, monuments, objects, and landscapes - came to be recognized as carriers of memories, narratives, and silences. This movement responds directly to the research question by demonstrating that the teaching of History, when articulated with the lived territory, expands the ways in which students read the past and attribute meaning to the present, moving beyond an approach centered on the transmission of decontextualized content.

The fifth and final mission, entitled "The Book of Life (Hyperhistorical)," invited students to connect global, national, state, and municipal historical events with their own life trajectories (Figure 8). Inspired by Luciano Floridi's notion of hyperhistory, this mission sought to demonstrate that History is not something distant from individuals but rather a relational and continuous process produced within hyperconnected ecosystems in which humans and technologies co-create together.

Throughout this process, students were invited to revisit the major events of each year of their lives and relate them to broader historical events, recognizing themselves as historical subjects situated within multiple temporal and spatial scales. The Book of Life was produced through a connective process involving physical books, digital platforms, and Generative Artificial Intelligence, such as ChatGPT and Canva, highlighting the co-production of knowledge between human and nonhuman actors. Based on the data produced during this mission (Table 3), it can be understood that the experience fostered a powerful process of self-knowledge and historical consciousness.

Figure 8 – Mission 05 with U.V.A[15]

Source: Sitnievski (2026).

Table 3 – Data Produced During Mission 05

Recurring Events Selected by the Students in the Book of Life	Examples (Taken from the Books of Life)	Students' Statements Highlighting the School as a Territory of Memory
Early biographical milestones	First ultrasound; Birth certificate; First haircut.	• "I started here in preschool, and it feels like I grew up together with the school."
Family and affective life	Birthdays; Adoption of a pet; Family trips.	

[15] THE BOOK OF LIFE (HYPERHISTORICAL): The Ancestral Verification Unit (U.V.A.) has been given the challenge of investigating how individual stories intertwine with major events in the History of humanity. Each agent must build their own Book of Life, recording their memories and personal experiences and connecting them to historical events in Brazil and around the world, as well as creating a digital "living library" with photographs, records, information, and excerpts from their History. MISSION 03: I suggest that you begin by listing all the years of your life and the main events... Remember, the book is yours... it doesn't have to be traditional!

Recurring Events Selected by the Students in the Book of Life	Examples (Taken from the Books of Life)	Students' Statements Highlighting the School as a Territory of Memory
Social networks and relationships	Meaningful friendships; Parties; Scouts; Romantic relationships.	• "Being in high school made me remember everything I had already experienced here." • "Every stage of my life is connected to something that happened at school." • "The school is a place where I experienced important moments of my life." • "The school trips are moments I will never forget." • "The school performances always marked important moments in my life." • "When I think about my history, the school appears in almost everything." • "I can see how much I have changed by looking at the experiences I had at school."
Municipal events	ExpoBento/Fenavinho; Anniversary of Bento Gonçalves; Mayoral election campaign.	
State events	2024 floods in Rio Grande do Sul; Kiss Nightclub tragedy; Fire at the Porto Alegre Public Market.	
National events	Presidential elections; Political changes; Environmental disasters.	
Global events	COVID-19 pandemic; Births and deaths of artists; Wars; Global crises.	
School trajectory	Beginning of preschool; First day of school; School Winter Festival; School trips; Beginning of secondary education.	

Source: Adapted from Sitnievski (2026).

Each student came to understand themselves as a biographical being, a historical subject, a member of communities, and an inhabitant of the OnLIFE ecosystem, in which the digital, the social, and the human are inseparable. The Book of Life thus became an archaeological process in which human and nonhuman memories (documents, photographs, and digital records) functioned as connected devices that preserve, activate, and expand memories.

In this way, the pedagogical practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves" constituted an ecological-connective experience of historical learning. It brought together students, the teacher, a nonhuman character, the city, families, memory, digital technologies, artificial intelligence, objects, archives, narratives, and historical events. Consequently, it was not merely a sequence of innovative activities but an ecology of learning in which multiple agents participated in the co-production of knowledge.

For the purposes of this article, this pedagogical practice is particularly relevant because it enables the problematization of conceptions of metacognition. Reflective processes concerning learning did not emerge solely as internal movements within each student but rather through the relationships established among the different actors involved. Thus, the practice demonstrates that thinking about one's own learning, within the context of the OnLIFE Education Paradigm and Morton's Ecological Thinking, means not only individually monitoring cognitive processes but also inhabiting connective ecologies in which knowledge is produced in a rhizomatic manner.

3.2 Data Production and Analysis

The production and analysis of the data generated through the ecological-connective pedagogical practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves" took place as an ongoing process, following the movements, shifts, and productions that emerged throughout the missions carried out with the students, digital technologies, artificial intelligences, the city, memories, and lived experiences. Consistent with the Cartographic

Research-Intervention Method, data were not understood as neutral or pre-existing information but rather as clues produced through encounters between human and nonhuman actors. Thus, each mission simultaneously functioned as a pedagogical dispositif, making it possible to observe not only what students learned but also how they came to perceive the connective ecologies within which historical knowledge was produced.

The data produced throughout the process encompassed multiple materialities: written narratives, photographic records, digital productions, spontaneous student statements, reflections developed within the clans, investigative walks, constructions created on digital platforms, hyperhistorical books, and productions co-created with Generative Artificial Intelligence, such as ChatGPT, Gemini, and Canva. The analysis of these productions revealed important shifts in how students understood History, learning, and their own roles as historical subjects. More importantly, it highlighted the emergence of second-order metacognition, understood not merely as individual awareness of one's own learning but as awareness of the connective and hybrid-intelligent ecologies in which human and nonhuman actors jointly participate in the production of knowledge.

The first clue emerging from the pedagogical practice concerns the shift in historical learning from a logic centered on the transmission of content toward a connective ecology of meaning co-production. Throughout the missions, students moved beyond the exclusive role of information recipients and became active participants who produced narratives, constructed interpretations, and established connections among their lived experiences, historical content, digital technologies, and inhabited territories. This shift became particularly evident during the Clan Mission, in which students co-created identities, narratives, symbols, and avatars using digital platforms and Generative Artificial Intelligence. In this context, reflection on learning extended beyond *"How do I learn?"* to encompass *"How do we, as a network, produce knowledge together with technologies and nonhuman intelligences?"*

By co-creating with ChatGPT, Gemini, Canva, and Genially, students moved beyond a utilitarian understanding of these technologies as mere tools for task execution and instead engaged in a process of making-with, in which their ideas were reorganized, returned, expanded, and transformed through connection with digital platforms and artificial intelligences. The final products - coats of arms, mascots, avatars, and narratives - could not be attributed exclusively either to humans or to machines but instead emerged as a third hybrid, produced through the relationship itself. In this context, metacognition came to involve awareness of this process of co-production: recognizing that knowledge does not originate from an isolated interiority but rather from the coupling of different forms of intelligence.

The second clue concerns the problematization of traditional conceptions of metacognition. Conventionally understood as the individual's internal capacity to monitor and regulate cognitive processes, metacognition, throughout the pedagogical practice, revealed itself as a distributed phenomenon. Reflective processes concerning learning emerged through collective experiences, connections with digital platforms, shared narratives, decisions made in collaboration with AI systems, and the shifts generated by the missions. Consequently, the unit of analysis moved beyond the individual student's consciousness to the connective ecology that sustains learning.

During the "Memories of the Holocaust" mission, this shift became particularly evident when students, especially members of the Humble Clan, who digitally recreated Anne Frank's House and the Auschwitz concentration camp in Minecraft, transformed historical content into a narrative, spatial, and affective experience. In recreating these spaces of memory within a virtual environment, students were required to select, interpret, organize, and represent historical elements, thereby reflecting upon how memory is constructed and narrated. In this case, second-order metacognition emerged through the awareness that learning History also involves understanding the modes, media, and environments through which memory is produced and continually renewed.

The third clue emerged during the mission "Fenavinho as the Living Memory of Bento Gonçalves," in which students connected local history with broader national historical processes. By recognizing that presidents from the period of the Brazilian Civil-Military Dictatorship had circulated through spaces within their own city and that streets, hotels, churches, and gateways preserved traces of this past, students shifted from viewing History as something

distant to perceiving it as inscribed within the territory they inhabit. This experience fostered an expanded reflection on historical learning: understanding the past came to mean critically reading the present, including street names, buildings, cultural events, and the material continuities embedded within the city itself. Here, metacognition emerged not merely as awareness of individual cognitive strategies but as a situated historical consciousness, co-produced through the relationships among memory, territory, and lived experience.

Within the same perspective, the fourth clue became particularly evident during the mission "The City Also Tells Stories...", in which students came to understand urban space as a living historical text. By recognizing streets, buildings, monuments, objects, digital maps, and means of transportation as carriers of memory and historical narratives, students shifted away from an anthropocentric perspective, perceiving that History is constituted not only through human actions but also through relationships with materialities, technologies, and territories. When students stated that *"the map also tells the history of the city"* or *"objects tell stories too,"* they demonstrated an expanded metacognitive awareness: historical knowledge emerged through the connections among human perception, technology, urban space, and material traces.

Within this mission, the use of Google Maps and virtual walks highlighted an important dimension of hybrid reflexivity. The digital map functioned not merely as a navigation resource but as an agent that reorganized students' perceptions of the city. By digitally exploring streets, zooming into images, identifying place names, and observing architectural continuities, students came to understand that technology transforms the ways in which territories are perceived, interpreted, and known. In this sense, second-order metacognition involves recognizing not only *"what I learned about the city"* but also *"how my connection with technology transforms the way I perceive the city and construct historical meaning."*

The clues produced throughout the pedagogical practice also revealed significant affinities with Timothy Morton's ecological thinking, particularly with the concept of the mesh. The understanding that no history exists in isolation permeated the entire pedagogical experience, from the initial dynamics of threads and connections to the construction of the Book of Life. Students progressively recognized that their personal trajectories are connected to family histories, the city, and national and global events, demonstrating a relational and coexistent understanding of History. Consequently, historical learning ceased to be understood as the simple assimilation of linear content and instead became configured as an ecological experience of connection among temporalities, memories, technologies, territorialities, and diverse forms of existence.

The fifth clue concerns the active participation of digital technologies and Generative Artificial Intelligence in learning processes. Rather than functioning instrumentally, digital platforms, maps, Minecraft, ChatGPT, Canva, Gemini and Genially participated in the co-production of knowledge as constitutive elements of hybrid-intelligent learning ecologies. These technologies generated images, reorganized narratives, suggested pathways, expanded students' repertoires, and returned new possibilities for interpretation. Thus, the pedagogical practice demonstrated that metacognitive reflection, within the OnLIFE Education Paradigm, requires understanding whether technologies are merely being used as tools or whether they are transforming the very nature of learning and knowing.

Finally, the mission "The Book of Life (Hyperhistorical)" most explicitly demonstrated the emergence of second-order metacognition. By relating global, national, state, and local historical events to their own biographical trajectories, students recognized themselves as historical subjects situated within multiple temporal and spatial scales. However, this recognition did not emerge in isolation; rather, it was produced through photographs, documents, digital records, family memories, editing platforms, and Generative Artificial Intelligence. The Book of Life thus became a hyperhistorical and hybrid artifact, in which human and nonhuman actors jointly participated in organizing, selecting, interpreting, and narrating lived experience.

Throughout this process, students' reflections on their own life histories were shaped by an ecology of intelligences. In constructing the Book of Life, students not only recalled events but also came to understand how

different records - birth certificates, photographs, news reports, family memories, digital data, and AI-generated responses - participated in the constitution of their narratives. Metacognition thus shifted from the question *"How did I think about my own history?"* to *"How was my history produced through the relationships among memory, documents, technologies, historical events, and intelligences?"* This shift evidences the transition from a subject-centered conception of metacognition toward a transorganic, ecological, and connective metacognition.

The data produced indicate that the U.V.A. pedagogical practice fostered the emergence of second-order metacognition, as students were encouraged to reflect not only on their own ways of learning but also on the networks, technologies, territories, memories, and intelligences that participate in the production of historical knowledge. Within this context, metacognition ceases to be a solitary act of mental self-regulation and instead becomes sympoietic reflexivity, that is, a critical awareness of the processes of making-with through which human and nonhuman actors participate in the invention of the self, the world, and History itself.

5 Final Considerations

This article sought to understand how ecological-connective pedagogical practices, guided by the OnLIFE Education Paradigm and Timothy Morton's Ecological Thinking, challenge conceptions of metacognition in History education. Based on the ecological-connective pedagogical practice "In the Wine Capital for 150 Days! The U.V.A. Expedition in Bento Gonçalves," it was possible to identify that reflective processes related to learning emerged not only within the students themselves but also through the relationships established among human and nonhuman actors, digital technologies, artificial intelligence, the city, memory, territory, and lived experience.

Throughout the investigation, a progressive shift was observed from a focus on the transmission of historically consolidated content toward connective ecologies of historical knowledge co-production. Within this movement, learning ceased to be understood merely as the individual assimilation of information and instead became constituted through inventive processes of co-invention. The missions developed throughout the pedagogical practice demonstrated that History can emerge from the relationships among students, digital platforms, family memories, urban spaces, artificial intelligences, and everyday experiences, fostering more ecological and connective ways of learning.

Within this context, the pedagogical practice made it possible to identify metacognitive processes from two complementary perspectives. The first concerns the metacognitive processes developed by the students themselves. By co-creating clans with Generative Artificial Intelligence, constructing historical environments in Minecraft, investigating the city through physical and digital walks, producing family trees, and creating the Hyperhistorical Book of Life, students began to reflect not only on what they were learning but also on how they were learning, with whom they were learning, and through which connections historical knowledge was being produced. Consequently, reflective processes were no longer confined exclusively to the interiority of the individual but instead emerged within hybrid-intelligent ecologies.

However, developing pedagogical practices within ecologically connected contexts does not eliminate—and indeed could not eliminate - metacognitive processes. On the contrary, such processes become even more necessary. Drawing on Piaget (1978a, 1978b, 1995), Schlemmer (2002, p. 211) defines metacognition as *"the awareness of the learning process (knowledge of or reflection upon the process of knowing); it is the knowledge we have about how we function cognitively, it is the cognition of cognition."* Nevertheless, within a context characterized by hyperconnectivity, digital platforms, and Generative and Agentic Artificial Intelligence, the very act of "knowing one's own knowing" requires important epistemological shifts. This is because knowledge is no longer produced exclusively by humans but increasingly emerges through transorganic connective acts among intelligences of different natures. Thus,

metacognition does not disappear; rather, it expands to include a critical awareness of the hybrid cognitive ecologies in which human and nonhuman actors jointly participate in the production of knowledge.

Digital technologies and Generative Artificial Intelligence assumed a central role in this process. Unlike an instrumental perspective in which technology is viewed merely as a tool subordinated to human action, digital platforms, algorithms, and artificial intelligences participated connectively in the production of the narratives, images, interpretations, and investigative pathways developed by the students. This made it possible to identify processes of coupling and sympoietic reflexivity, in which metacognitive reflection emerged through the very act of making-with human and nonhuman intelligences. Consequently, students came to recognize that knowledge is not produced in isolation by the human mind but instead emerges within ecological-connective networks.

The second perspective concerns the metacognitive processes developed by the teacher-researcher herself. The inventive pedagogical practice required continuous shifts in her understanding of teaching, learning, and the role of the teacher within hybrid-intelligent contexts. Throughout the research process, it became evident that pedagogical work can no longer be sustained exclusively through transmissive, linear, or anthropocentric perspectives of education. Teaching itself came to be constituted as an ecological experience of accompaniment, curation, problematization, and the networked co-production of meaning.

By proposing the notion of second-order metacognition within the OnLIFE Education Paradigm, this study seeks to extend the theoretical legacy of metacognition beyond the centrality of the biological brain and the isolated human subject. Metacognition ceases to be understood solely as the "cognition of cognition" performed internally by an individual subject and instead becomes conceived as a critical awareness of the hybrid ecologies of cognition in which human and nonhuman actors jointly participate in the production of knowledge.

Accordingly, the OnLIFE Education Paradigm and Ecological Thinking offer important contributions for rethinking theories of learning and pedagogical practices in education. By challenging modern dualisms such as human versus technology, face-to-face versus virtual, and subject versus object, these perspectives make it possible to understand learning as an ecological, connective, and transorganic process. The pedagogical practice analyzed in this study therefore demonstrates the potential of ecological-connective pedagogies capable of shifting education away from models centered exclusively on the individual subject toward hybrid-intelligent ecologies of knowledge co-production.

Finally, we argue that thinking about metacognition in the contemporary context requires an epistemological, methodological, and ontological shift. Whereas metacognition was once understood as the human being reflecting upon his or her own thinking, it now involves a critical awareness of the networks, intelligences, algorithms, platforms, and environments that participate in the production of knowledge. Within this scenario, the human being neither disappears nor becomes obsolete but rather ceases to occupy an exclusively central position and instead becomes a co-author within ecologies of intelligences. Metacognition thus ceases to constitute a solitary act and instead emerges as an ecological-connective, distributed, and hybrid phenomenon, offering new pathways for reimagining education in the present time.

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