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Ecological Perspectives in Language Learning: *Mapping theoretical diversity for pedagogical transformations*

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Abstract

Ecological perspectives represent a paradigm shift in language learning, moving from reductionist models to frameworks that embrace complexity, relationality, and context-embeddedness. This state-of-the-art paper examines five major ecological approaches: affordance-centered (Gibson, van Lier), systems-based (Bronfenbrenner, CHAT), complexity/dynamic systems theory (Larsen-Freeman), critical ecological (ecolinguistics), and holistic/situated perspectives, and their classroom adoption through affordance-based pedagogy, multi-system interventions, and ecopedagogy. Six paradigm shifts mark their influence: from input to affordance, individual to relational, linear to dynamic, decontextualized to embedded, transmission to transformation, and technology as tool to ecological mediator. These shifts have profound implications for pedagogy, research, teacher education, and policy, empowering teachers to make informed, context-appropriate decisions while foregrounding questions of morality, equity, and justice. As digital transformation and climate crisis reshape educational landscapes, ecological perspectives offer essential conceptual tools for creating language education that is more effective, equitable, and empowering.

Keywords: *language learning, ecological perspectives, affordance theory, system-based theory, complexity theory, transformative pedagogy*

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1. Introduction

Language learning is a complex process shaped by multiple factors. Learners develop linguistic abilities through ongoing interaction with individuals, texts, technologies, and contexts that influence and are influenced by their actions. Traditional approaches to understanding language learning have often relied on reductionist frameworks that isolate variables, measure discrete outcomes, and seek linear cause-and-effect relationships. While these approaches have become valuable insights, they are insufficient to capture the messy, context-dependent, and emergent nature of how people learn languages in real-world settings (Novawan et al., 2022).

Ecological perspectives offer a fundamentally different perspective. Rooted in ecological psychology (Gibson, 1979), bioecological systems theory (Bronfenbrenner, 1979), and complexity theory (Larsen-Freeman, 1997), ecological approaches view language learning not as the accumulation of discrete linguistic items but as the development of relationships between active learners and their environments. Language is understood as inseparable from the physical, social, cultural, and historical contexts in which it is used (van Lier, 2004). Learning emerges from perception-action cycles, distributed across minds and materials, shaped by affordances and constraints, and influenced by forces operating at multiple scales from moment-to-moment interactions to long-term societal changes. The ecological turn in language education represents more than a theoretical shift, it is a response to the realities of 21st-century learning (Larsen-Freeman, 2018; Kramsch, 2008). Digital technologies have transformed the affordance landscape, creating new opportunities and inequalities (Blin, 2016; Liu, 2018). Climate crisis demands that educators consider their role in fostering environmental awareness and sustainability (Stibbe, 2020). Increased mobility and multilingualism challenge simplistic notions of language boundaries and competence (Souto-Manning et al., 2021). In this context, ecological perspectives provide conceptual tools to understand and respond to complexity rather than simplify it away.

The ecological perspectives share at least three defining characteristics (Bronfenbrenner, 1979; van Lier, 2004, 2010; Kramsch, 2008; Larsen-Freeman, 2018). First is relationality. From this point of view, earning is understood as emerging from relationships rather than residing within individuals. Knowledge is not transmitted from teacher to student like water poured into an empty vessel; instead, it co-emerges through interactions among learners, teachers, materials, and contexts. The unit of analysis is not the isolated learner but the learner-in-environment. Second is context-embeddedness. Context is not background scenery or a variable to be controlled, but is constitutive, meaning that learning and context mutually shape one another. A learner's actions transform the environment, which in turn affords new possibilities for action. Third is

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dynamism. Ecological systems are characterized by continuous change, emergence, and adaptation. Development is non-linear, with small changes sometimes producing large effects and vice versa. Variability is not noise to be eliminated but a signal to be understood, reflecting the adaptive processes through which learners navigate their environments.

This paper provides a comprehensive overview of how ecological perspectives have been adopted in language learning by addressing three primary objectives: (1) identifying types of ecological perspectives and mapping the theoretical diversity within the ecological strands, (2) explaining classroom adoption by examining how educators implement ecological principles in real pedagogical contexts, and (3) analyzing significant influences by assessing how ecological perspectives have transformed language education research, pedagogy, and policy.

2. Types of ecological perspectives in language learning

Ecological perspectives in language education do not constitute a monolithic theory. They form a field of related approaches, each emphasizing different dimensions of the learner-environment relationship. Five major types have emerged in the literature, recognizing that these categories overlap and complement one another.

2.1. Affordance-centered approaches

Affordance-centered perspectives draw from James Gibson's (1979) ecological psychology and Leo van Lier's (2000, 2004) pioneering application to language education. At the heart of this approach is the concept of *affordance*: the relationship between an organism's capabilities and features of the environment that invite or constrain action. Gibson (1979) argued that perception is not the passive reception of sensory information but the active detection of meaning in the environment. A chair, for instance, affords sitting for a human but not for an ant; stairs afford climbing for an adult but may constrain movement for someone using a wheelchair. Affordances are therefore neither purely objective properties of objects nor merely subjective interpretations, but relational phenomena that emerge from the fit between organism and environment (Gibson, 1979).

Van Lier (2000, 2004) adapted this idea for language learning, arguing that linguistic development emerges when learners perceive and act upon opportunities in their environment. Language learning affordances might include a conversation with a friend, a text to read, a word that catches attention, a gesture that clarifies meaning, or feedback from a teacher. Crucially, affordances are not equivalent to input, the

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traditional notion that language is data to be processed. Instead, affordances are possibilities for meaning-making that learners actively perceive and engage with through perception-action coupling. In van Lier's (2004) words, the ecological approach sees learning as a process of increasing participation in a semiotic world, where learners engage with signs and meanings in their environment through active perception and interaction.

The shift from input to affordance represents a fundamental reconceptualisation of language learning (Novawan et al., 2022). Traditional input-processing models treat language as an object, data entering a cognitive system, being manipulated through internal processes, and emerging as output. This computational metaphor dominates the second language acquisition research and informs widespread practices like listening to recordings, memorizing vocabulary lists, and completing grammar exercises. Affordance theory rejects this static, objectified view. Language is not data to be transmitted but relations to be enacted (van Lier, 2004, 2010). Learning occurs not through passive processing but through active engagement in meaningful activity. This has profound implications. Teachers become facilitators who design environments rich in affordances rather than deliverers of input, and assessment focuses on what learners can do in context rather than what they know in isolation, and learner agency moves from the periphery to the centre, as learners' perceptions and actions determine which potentialities become actualised (van Lier, 2000, 2004; Novawan et al., 2022).

2.2. System-based approaches

Systems-based ecological perspectives conceptualize learning as embedded within nested layers of context, each influencing and being influenced by the others. Urie Bronfenbrenner's (1979) bioecological model identifies five nested systems that shape human development. The microsystem comprises immediate environments where learners engage in face-to-face interactions, classroom, home, peer groups. Proximal processes, which are regular and reciprocal interactions, serve as the engines of development at this level. The mesosystem encompasses connections among microsystems, such as home-school communication and peer group-classroom dynamics. Strong mesosystem links amplify developmental opportunities. The exosystem includes settings that indirectly influence learners, such as school policies, parental workplaces, and community resources. Decisions made here affect microsystem conditions. The macrosystem represents broad cultural patterns, ideologies, and policies (language policies, educational philosophies, and societal attitudes toward multilingualism) that shape possibilities at all other levels. Finally, the chronosystem captures changes over time, including historical events such as the

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COVID-19 pandemic, developmental transitions, such as starting university, and generational shifts between digital natives and immigrants (Bronfenbrenner & Morris, 2006).

The power of Bronfenbrenner's model lies in its recognition that learning cannot be explained by examining classrooms alone. A learner's language development reflects the quality of proximal processes in the microsystem, the coherence of connections in the mesosystem, the resources available through the exosystem, the cultural values of the macrosystem, and the historical moment of the chronosystem. Bronfenbrenner and Morris (2006) emphasized that proximal processes are the primary mechanisms producing development, but their effectiveness varies systematically as a function of the characteristics of the developing person, the immediate and more remote contexts, and the time periods in which the processes take place.

Cultural-Historical Activity Theory, rooted in Vygotsky's (1978) sociocultural theory and elaborated by Engeström (1987) and Lantolf and Thorne (2006), analyzes human activity as mediated by tools (both material and symbolic) within social systems (Ikeda & Binarkaheni, 2024). A prototypical activity system comprises subjects (e.g., learners), objects (goals or problems to be worked on), mediational tools (such as language, technologies, and cultural artifacts), rules (explicit and implicit norms), community (those who share the object), and division of labor (the distribution of roles and responsibilities) (Engeström, 1987; Lantolf & Thorne, 2006).

From a CHAT perspective, language learning is not simply the internalization of linguistic forms, but participation in activity systems where language mediates goal-directed action and social relations (Lantolf & Thorne, 2006). For example, when students collaboratively write a group report, they engage with linguistic tools such as vocabulary, grammatical resources, and genre conventions; follow rules including assignment guidelines and academic integrity norms; coordinate with community members like peers and teachers; and navigate a division of labor determining who researches, drafts, edits, or presents (Engeström, 1987; Lantolf & Thorne, 2006). Learning, in this view, emerges through the contradictions, tensions, and negotiations within and between activity systems, for instance, when institutional assessment rules clash with students' collaborative practices, prompting reflection, reorganization of roles and tools, and ultimately transformation of both the participants and the activity itself (Engeström, 1987; Lantolf & Thorne, 2006).

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2.3. Complexity and dynamic systems theory

Complexity and Dynamic Systems Theory (CDST) brings insights from physics, biology, and complex adaptive systems research into the study of language learning, offering an alternative to linear, stage-based accounts of development (Larsen-Freeman, 1997; de Bot et al., 2007). Larsen-Freeman (1997, 2015) has been particularly instrumental in adapting these concepts for second language acquisition, arguing that language and its development constitute complex systems characterised by nonlinearity, emergence, self-organisation, and sensitivity to initial conditions. Drawing on this work, she identifies four key properties of complex dynamic systems that are especially relevant for understanding language learning trajectories such as historicity, adaptiveness, nonlinearity, and emergence (Larsen-Freeman, 2015).

Historicity means that a system's current state depends on its history, with past experiences shaping present possibilities and creating path-dependence (Larsen-Freeman & Cameron, 2008). For language learners, this implies that prior knowledge, beliefs, affective dispositions, and learning experiences form the foundation from which new forms and uses of language can emerge; two learners exposed to the same "input" will not develop identically because they bring different histories to the interaction (de Bot et al., 2007). Adaptiveness refers to how systems respond to internal and external changes, adjusting to maintain or regain functioning in the face of perturbation (Larsen-Freeman, 2015). In pedagogical terms, this is visible when learners revise strategies in response to feedback, shift goals when tasks prove too easy or too difficult, or reorganize their study habits after experiencing success or failure (de Bot et al., 2007; Verspoor et al., 2011).

Nonlinearity captures the idea that small changes can generate disproportionately large effects and, conversely, that great efforts may sometimes produce only minimal apparent change (Larsen-Freeman, 1997; Larsen-Freeman & Cameron, 2008). A single encouraging comment from a teacher, for example, may trigger a dramatic increase in a learner's confidence and participation, while weeks of intensive study might yield little observable progress until a sudden "breakthrough" moment when previously fragmented knowledge coalesces into a new pattern of use. Emergence explains how such new patterns arise spontaneously from interactions among system components rather than being directly taught or imposed from outside (Larsen-Freeman, & Cameron, 2008). Fluency, for instance, is not typically acquired as a discrete skill; instead, it emerges from complex, ongoing interactions among vocabulary growth, grammatical resources, pronunciation, processing speed, confidence, and opportunities for practice (Verspoor et al., 2011).

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Larsen-Freeman and Cameron (2008) emphasize that complex systems are open, in the sense that they continually exchange energy, information, and resources with their environments, and that they exhibit self-organization, whereby order and new structures arise from local interactions without central control. In language learning, this means that development cannot be fully predicted or controlled externally; learners are active agents in organizing their own learning processes as they interact with tasks, interlocutors, and contexts (Larsen-Freeman, 2015). CDST therefore challenges stage-based developmental models that assume all learners progress through fixed, universal sequences (Ellis, 2008). Instead, development is understood as following multiple, context-sensitive pathways, with learners exhibiting variability that reflects adaptive processes rather than errors to be eliminated (de Bot et al., 2007; Verspoor et al., 2011). Longitudinal studies inspired by CDST show that what appears as variability or even regression at certain points may actually signal system reorganization at deeper levels, presaging qualitative shifts to new attractor states in the learner's interlanguage (de Bot et al., 2007; Verspoor et al., 2011).

2.4. Critical ecological approaches

Critical ecological approaches integrate ecological thinking with critical theory, foregrounding how power, inequality, and ideology shape language learning environments rather than treating ecology as a neutral backdrop (Steffensen & Fill, 2014; Stibbe, 2020). These perspectives foreground a set of uncomfortable but essential issues: which language varieties and literacies are treated as legitimate, who is granted or denied access to meaningful learning opportunities, whose interests educational technologies and curricula ultimately serve, and how language education contributes to, or helps to challenge, social and environmental injustice in local and global contexts (Freire, 1970; Paris & Alim, 2017; Selwyn, 2019).

Within this, ecolinguistics focuses explicitly on relationships between language and the ecological systems that sustain life. Stibbe (2020) shows in detail how recurrent discourse patterns shape attitudes toward nature, documenting ways in which stories of endless economic growth, human dominance, and consumerist lifestyles normalize environmental destruction, while alternative stories foreground care, interdependence, and limits. Ecolinguistic analysis identifies linguistic features (metaphors, frames, evaluations, erasures) that either conceal or make visible ecological realities, and uses this lens to explore how language can support movements toward sustainability rather than reinforce environmentally harmful ideologies (Stibbe, 2020; Steffensen & Fill, 2014). Eco-critical language awareness extends this analytic project into pedagogy by inviting learners to interrogate the environmental implications of texts they encounter

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and produce, and by developing frameworks for classifying discourse as *eco-beneficial* (supporting ecological wellbeing), *eco-ambivalent* (sending mixed or unclear messages), or *eco-destructive* (normalizing harm to ecosystems and non-human life) (Stibbe, 2020).

The integration of language education with environmental and sustainability concerns thus represents a growing trend within ecological approaches. Recent work in transformative language teaching for sustainability argues that language learning can and should simultaneously develop communicative competence and environmental consciousness, since linguistic choices inevitably reflect and reinforce particular relationships with the natural world (Stibbe, 2020). From this perspective, language educators are challenged to consider not only the forms and functions of language, but also the ideologies and worldviews that language practices perpetuate or transform—for example, whether classroom discourse reproduces anthropocentric, extractivist assumptions or opens space for more relational, care-oriented ways of speaking about humans and nature (Steffensen & Fill, 2014; Paris & Alim, 2017).

Critical ecological approaches also extend to the digital domain, examining how educational technologies and artificial intelligence reconfigure the ecologies of language learning. As digital platforms and AI-driven systems increasingly mediate access to language learning opportunities, critical scholars ask who benefits from these technologies, whose data is collected and monetized, and how algorithmic systems may reproduce or intensify existing social and educational inequalities (Selwyn, 2019). Ecological analyses of technology-enhanced language learning emphasize that digital tools are never neutral: they privilege certain languages, norms, and forms of participation, and they embed particular institutional and commercial interests (Blin, 2016; Liu, 2018). Building on this, Novawan et al. (2022) argue that ecological perspectives in technology-mediated language education can function as a "vitamin" when they illuminate how power and access operate across the ecology—encouraging more just, context-sensitive pedagogical choices—but risk becoming "toxic" if they obscure responsibility or naturalize inequitable arrangements under the guise of complexity.

2.5. Holistic and situated approaches

Holistic and situated perspectives emphasise learning as participation in communities of practice rather than as the acquisition of decontextualised knowledge by isolated individuals. Lave and Wenger's (1991) theory of situated learning argues that learning is not primarily a cognitive process of internalizing information but a participatory

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process involving changing relationships between persons and the social worlds they inhabit. In their account, newcomers enter a community of practice as legitimate peripheral participants and, over time, move toward fuller participation as they appropriate the community's ways of doing, talking, and being (Lave & Wenger, 1991). From this perspective, language learning means becoming a particular kind of person, someone who can participate meaningfully in specific social practices, rather than simply accumulating grammatical forms or vocabulary items. Situated learning thus challenges assumptions that learning occurs mainly through explicit instruction or individual cognitive processing and instead positions learning as legitimate peripheral participation in authentic practices where identities, activities, and environments mutually constitute one another (Lave & Wenger, 1991; Wenger, 1998).

Place-based education extends this participatory view by grounding learning in local contexts and treating communities and environments as integral parts of the curriculum. In place-based approaches, the local community and environment serve as the starting point for teaching concepts across subjects, including language arts (Sobel, 2014). For language learners, this can mean documenting local history through interviews with elders, investigating environmental issues affecting the neighbourhood, or collaborating with community organisations on real projects; in each case, language is used as a tool for authentic participation in community life rather than as an abstract object of study. Sobel (2014) argues that place-based education, by emphasising hands-on, real-world learning experiences, increases academic achievement, helps students develop stronger ties to their community, enhances their appreciation for the natural world, and fosters a heightened commitment to serving as active, contributing citizens. In this way, holistic and situated approaches align with ecological perspectives by treating learning, identity, and place as inseparable.

Recent research also explores families as language learning ecosystems, recognizing that much language development occurs through everyday interactions during mealtimes, bedtime routines, shared screen time, travel, and community activities. Work on family language policy and ecological perspectives in early language education shows that the home is a primary language ecology in which children's linguistic repertoires are shaped through ongoing interaction with parents, siblings, and extended family (King, 2023; Schwartz, 2018). Within this ecology, parents' beliefs, practices, and management of language use along with children's own agency co-construct opportunities for learning multiple languages in dynamic ways (Curdt-Christiansen, 2009; King, 2023). Interventions that support family language learning deliberately build on families' "funds of knowledge" and cultural practices, treating parents as knowledgeable agents rather than deficits to be corrected, and aim to

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strengthen intergenerational bonds while expanding learning beyond formal instruction into everyday life (Moll et al., 1992; Schwartz, 2018). Such work reinforces the holistic insight that language learning is distributed across home, school, and community settings, and that effective pedagogy must engage with the full ecology of learners' lived experiences.

3. Adoption in classroom practice

Having examined the theoretical diversity of ecological perspectives, we now turn to how these frameworks translate into pedagogical practice. Affordance-based pedagogy operationalizes van Lier's (2004) theoretical insights into practical teaching strategies. Rather than following rigid lesson plans focused on predetermined linguistic targets, affordance-based teachers cultivate learning environments rich in meaning-potential and develop learners' abilities to perceive and act upon opportunities (van Lier, 2010). A defining feature is reflection-in-action, the ability to notice and respond to emergent learning opportunities in real time (Schön, 1983). Teachers develop this capacity through deliberate practice, such as collaborative lesson planning that anticipates multiple pathways and reflective journals documenting unexpected learning moments. When a student makes an unexpected grammatical error that reveals interesting conceptual thinking, an affordance-sensitive teacher might pause to explore that thinking with the class rather than simply correcting and moving on (van Lier, 2000).

Traditional lesson planning specifies linguistic objectives in advance, but affordance-based planning balances structured objectives with openness to emergent language needs. Teachers might plan core activities like discussions or projects while remaining flexible about which linguistic features to highlight based on what emerges as relevant and noticeable to learners (van Lier, 2004). Research on emergent grammar teaching shows that learners benefit more from instruction timed to match their noticing and questions than from pre-planned grammatical sequences (Larsen-Freeman, 2003). This does not mean abandoning planning; rather, it means planning for emergence designing activities likely to surface important linguistic issues while remaining responsive to what actually unfolds (Blin, 2016). Anderson (2015) demonstrates how this approach can be systematically integrated into ELT practice through frameworks that help teachers identify, create, and respond to learning opportunities in real time, shifting the focus from covering material to uncovering learning potential.

Affordance-based pedagogy prioritizes authentic materials and tasks that reflect learners' interests and goals. Rather than artificial textbook dialogues, teachers use podcasts, news articles, community texts, and learner-generated content. Tasks involve

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genuine communication, such as solving real problems or expressing personal perspectives (Beckett & Miller, 2006). Learner autonomy is central to this approach, as affordance perception is inherently personal, what one learner notices and acts upon differs from another (van Lier, 2010). Teachers scaffold autonomy through structures like learning portfolios where students document affordances they have perceived and acted upon, encouraging them to take ownership of their unique learning trajectories.

Systems-based interventions demonstrate how attention to multiple ecological layers can enhance outcomes. Drawing on Bronfenbrenner's (1979) framework, effective ecological interventions operate at multiple levels simultaneously. This involves comprehensive ecological assessment across the microsystem of classroom interactions, the mesosystem of home-school communication, the exosystem of school policies, and the macrosystem of cultural attitudes (Bronfenbrenner & Morris, 2006). Instead of treating learners in isolation, teachers design learning experiences that explicitly strengthen connections between these systems. For example, pedagogical activities might bridge home and school cultures, or advocacy efforts might address exosystemic constraints like resource access. By aligning supports across these levels, educators create a coherent ecology that supports development more effectively than classroom-only interventions (Bronfenbrenner, 1979).

Complexity and Dynamic Systems Theory informs teaching practices that embrace unpredictability and value variability (Larsen-Freeman, 2015). Stelma & Kostoulas (2024) propose that CDST understanding empowers teachers by validating the intuition that teaching is context-dependent and requires constant adaptation. Teachers engaging with CDST recognize different types of teaching activity, moving between establishing stable routines (normative activity) and responding flexibly to emerging needs (contingent activity). Normative activities honor the historicity of the system by leveraging past experiences to create efficient patterns, while contingent activities respond to real-time feedback (Stelma & Kostoulas, 2024). Furthermore, creative activities introduce novelty that can produce nonlinear effects, where small changes, such as introducing a new material or perspective, catalyze significant learning (Larsen-Freeman, 2015).

Critical ecological pedagogy often takes the form of project-based learning addressing local issues. Projects that engage language learners in ecological experiences in their local environments demonstrate how dual goals can be achieved simultaneously: developing language proficiency while heightening environmental awareness (Stibbe, 2020). For instance, students might explore ecological themes in their communities, generating texts that are then analyzed to understand how language constructs relationships between humans and nature. Stibbe (2020) illustrates how such approaches

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can lead to shifts in students' discourse, moving from language that distances them from nature to language that reflects interconnectedness. Importantly, these environmental outcomes parallel linguistic gains, as students develop richer vocabulary and genre awareness through meaningful, purposeful work.

Technology-mediated ecological approaches recognize digital technologies as mediators of affordances within complex systems rather than simple tools (Blin, 2016). Liu's (2018) research on Computer-Assisted Language Learning (CALL) through an ecological lens finds that effective teachers focus on how learners perceive and engage with technology, rather than just the technical features of the tools. Learner agency emerges from the relationship between learners' goals and technological affordances, with teachers playing a crucial role in facilitating this agency (Liu, 2018). Successful technology integration, therefore, depends on attending to the broader learning ecology, including institutional constraints and social norms, rather than treating technology as an isolated variable (Blin, 2016).

4. Significant influences on language learning

The reconceptualization from input to affordance represents a fundamental shift in how we understand language learning. Traditional models treat language as information to be transmitted: teacher provides input, learner processes it, and learning occurs through accumulation (Gass, 1997). This computational metaphor assumes language exists as objective data external to learners. Affordance theory rejects this view, positing that learning is the development of relationships (van Lier, 2000, 2004). Affordances, opportunities for meaning-making perceived and acted upon by learners, replace input as the central construct. Learning emerges from active engagement rather than passive reception (van Lier, 2004). This transforms the teacher's role from input-provider to affordance-facilitator who cultivates learners' perceptual abilities (van Lier, 2000). Consequently, learner agency becomes central, as affordances only support learning when learners actively perceive and act upon them.

Ecological perspectives also reframe learning from an individual to a relational process. Traditional cognitive approaches locate learning within individual minds, treating social factors as external influences (Gass, 1997). In contrast, ecological perspectives view knowledge as distributed across people, materials, and contexts (Lantolf & Thorne, 2006). Learning emerges from participation in social activity (Lave & Wenger, 1991), shifting the unit of analysis to the learner-in-environment (van Lier, 2004). This relational turn emphasizes the quality of interactions between learners, teachers, and communities. Collaborative learning becomes essential because learning is

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inherently collaborative, not just a method for practice. It also brings issues of identity and belonging to the forefront, as participation in a community of practice involves negotiating who one is in relation to others (Norton, 2013).

A third significant influence is the shift from linear to dynamic models of development. Stage-based models have long assumed learners progress through fixed sequences (Ellis, 2008). Complexity and Dynamic Systems Theory challenges this, portraying development as nonlinear, characterized by regressions, breakthroughs, and multiple pathways (Larsen-Freeman, 1997). Variability in learner performance is reinterpreted not as noise or error, but as a signal of adaptive processes (Verspoor et al., 2011). This validates teachers' observations that learning is messy and unpredictable (Stelma & Kostoulas, 2024). It changes the understanding of errors from deficits to be eliminated to signs of experimentation and system reorganization (Larsen-Freeman & Cameron, 2008). De Bot et al. (2007) provide evidence that such variability often signals imminent qualitative shifts in learner capabilities.

Furthermore, ecological perspectives have moved the field from decontextualized to embedded views of language. Traditional instruction often strips language of context for efficiency (Gass, 1997). Ecological approaches argue that language is inseparable from context, and meaning emerges from specific use (van Lier, 2004). This shifts priorities toward authentic materials situated in learners' lived experiences (Lave & Wenger, 1991). Place-based education (Sobel, 2014) and culturally sustaining pedagogies (Paris & Alim, 2017) exemplify this shift by grounding learning in local environments and cultural knowledge. The embedded perspective recognizes that transfer cannot be assumed; pedagogy must explicitly support learners in adapting knowledge across authentic settings (Beckett & Miller, 2006).

Finally, ecological perspectives support a shift from transmission to transformation. While transmission models view success as reproducing knowledge (Freire, 1970), ecological perspectives align with transformative education that develops critical consciousness and agency (Mezirow, 1997). Learning transforms learners' identities and capabilities through meaningful activity (van Lier, 2004). Language education thus integrates transformative goals such as environmental awareness (Stibbe, 2020) and social justice (Paris & Alim, 2017). Linguistic development is embedded within these larger purposes, with research suggesting that purposeful activity produces stronger linguistic gains than decontextualized practice (Stibbe, 2020). Technology is similarly reconceptualized not as a mere tool for transmission, but as an ecological mediator that reshapes relationships and possibilities within the system (Blin, 2016; Liu, 2018).

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5. Implications and future directions

Ecological perspectives have transformed language education in theory and practice, yet significant work remains. For pedagogy, ecological thinking challenges one-size-fits-all approaches, demanding responsiveness to specific contexts (van Lier, 2004). Quality of engagement, depth and connection to learners' lives, takes priority over mere quantity of exposure (van Lier, 2010). Learner-centered approaches must honor agency while attending to contextual constraints, recognizing that pedagogical success is local and situated (Lave & Wenger, 1991). Anderson (2015) suggests that implementing these principles requires disciplined practice in environmental design and responsiveness, ensuring that affordance-based pedagogy is systematic rather than unstructured. Teachers must cultivate the ability to navigate complex linguistic landscapes, offering varied opportunities across different modalities to accommodate diverse learner strengths (Larsen-Freeman, 2015).

For research, ecological perspectives demand methodological innovation. Longitudinal designs are essential to capture the nonlinear dynamics of development that cross-sectional studies miss (Verspoor et al., 2011). Mixed methods that combine quantitative measures of change with qualitative understandings of process are needed to capture the full complexity of the learning ecology (Dörnyei, 2007). Moreover, critical perspectives must be foregrounded. Research should ask not only how learning happens, but also how power and equity operate within learning ecologies (Paris & Alim, 2017). Questions of who benefits from current arrangements and how research can contribute to more equitable education are central. Practitioner research is also vital; teachers' situational expertise is a rich source of ecological insight, and collaborative inquiry can generate practical knowledge that complements formal research (Johnson, 2015).

For teacher education, preparation programs must equip teachers with ecological literacy, understanding principles like relationality and emergence (van Lier, 2004). Reflective practice is crucial for developing the capacity to notice affordances and adapt instruction in real time (Schön, 1983). Situational awareness enables teachers to understand the possibilities within their micro- and macrosystems (Stelma & Kostoulas, 2024). Teacher education should also model ecological principles, involving field experiences in diverse settings and action research projects (Johnson, 2015). Furthermore, training in technology integration should move beyond technical skills to understanding technology as a mediator of relationships and agency (Blin, 2016).

For policy, ecological perspectives suggest a move away from rigid standardization toward support for flexibility (Larsen-Freeman, 2015). Policies should enable teachers

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to adapt curricula to local contexts rather than enforcing uniform compliance. Resources should support interdisciplinary teaching and equitable access to learning opportunities (Paris & Alim, 2017). Recognition of informal learning in families and communities is also essential, acknowledging that language development extends beyond the school walls (Selwyn, 2019). Assessment reform is a critical implication; moving toward portfolios and longitudinal tracking aligns better with the nonlinear nature of development than high-stakes standardized testing (Verspoor et al., 2011). As Novawan et al. (2022) caution, the challenge for policy is to ensure that ecological frameworks function as a "vitamin" to nourish practice rather than becoming a source of overwhelming complexity. Policies must create conditions that enable responsive, context-sensitive pedagogy, treating teachers as professionals with the expertise to navigate their specific educational ecologies (Stelma & Kostoulas, 2024).

5. Conclusion

Ecological perspectives have fundamentally reshaped language education through five complementary frameworks: affordance-centered, systems-based, complexity/dynamic systems, critical ecological, and holistic/situated approaches, and six paradigm shifts: from input to affordance, individual to relational, linear to dynamic, decontextualized to embedded, transmission to transformation, and technology as tool to ecological mediator.

These perspectives are emergent because they appreciate the complexity of real-world language learning. Unlike reductionist models that simplify for control, ecology embraces messiness as reality: learning varies across individuals and contexts, not due to flawed methods but because humans and environments are diverse; context is constitutive, not background; relationships profoundly shape development; and small changes can produce large effects. By providing tools to understand rather than eliminate complexity, ecological perspectives empower teachers to make informed, context-appropriate decisions while validating their situated expertise. They also foreground justice, prompting urgent questions about access, equity, and whose interests are served, especially critical as technologies reshape education and climate crisis demands transformation.

Looking ahead, digital transformation, climate crisis, mobility, and social justice movements will continue shaping ecological perspectives. Realizing their potential requires action from all stakeholders: researchers must innovate methodologically and prioritize equity; teachers must cultivate ecological literacy and situational awareness;

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teacher educators must model ecological principles; policymakers must enable flexibility and address inequities; and learners must recognize their agency.

Ecological perspectives represent not a fixed destination but an ongoing journey. By embracing relationality, honoring context, and attending to power and justice, they offer pathways toward language education that is more effective, equitable, and empowering for all.

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