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Sustainable Architecture and Environmental Challenges: A Literature Review Toward the Design of an Immersive Pedagogical Park

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Abstract: More than three decades after the Brundtland Report, sustainable architecture has evolved from a corrective response to energy crises toward a holistic paradigm engaging landscape, spatial experience and human cognition. Yet contemporary environmental education facilities still struggle to translate this evolution into spatial devices capable of transforming abstract ecological knowledge into a lived, embodied understanding of ecological processes. This article presents a systematic literature review structured around three interconnected axes: the theoretical and technical foundations of sustainable architecture and its operational pillars; the typology and territorial implications of contemporary environmental challenges and the responsibilities they assign to the design disciplines; and the theoretical framework of immersive and experiential learning as an architectural principle. Drawing on architectural theory, environmental psychology, museology and pedagogy, and supported by a comparative analysis of three international precedents, the Eden Project, Dino's Park and Ludogaia, the review identifies a persistent gap in the literature: the difficulty of reconciling scientific rigor, sensory immersion and contextual relevance, particularly within tropical climatic and cultural settings such as Cameroon. The article establishes four operative principles, sensory engagement, spatial narrative, experiential transmission and environmental performance, that ground the conceptual and programmatic basis for an immersive pedagogical park capable of reconnecting users with ecological processes and reinforcing environmental awareness in the Cameroonian context.

Keywords: *Sustainable Architecture; Immersive Learning; Environmental Education; Pedagogical Park; Bioclimatic Design; Experiential Learning; Ecological Literacy; Tropical Architecture.*

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I. INTRODUCTION

Architecture has always been one of the principal instruments through which societies negotiate their relationship with the natural world. From vernacular construction shaped by climate and available resources to the industrialized building sector of the twentieth century, the built environment has alternately mitigated and amplified the pressure exerted by human activity on ecosystems. This dual condition has become acute in the current period, marked by climate disruption, biodiversity loss and accelerating urbanization, a period in which the building sector is simultaneously a major source of greenhouse gas emissions and a strategic lever for ecological transition [1].

Beyond its technical and environmental dimension, architecture is also confronted with a pedagogical challenge that the literature addresses only partially: how can the built and landscaped environment become an active medium of environmental education rather than a passive container for didactic content. Existing environmental facilities, whether classical educational parks, ecoparks or nature centers, tend to privilege either an illustrative logic centered on signage and information, or a spectacular logic centered on entertainment, without fully reconciling scientific rigor, sensory immersion and lasting behavioral change.

This article addresses the following central question: how can the theoretical and technical foundations of sustainable architecture be articulated with the principles of immersive and experiential learning to conceive a pedagogical

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park capable of reconnecting users, in a durable and sensitive manner, with the environmental challenges of their territory. To answer this question, the article develops a systematic literature review structured around three complementary axes: the operational foundations of sustainable architecture; the typology and territorial implications of contemporary environmental challenges; and the theoretical framework of immersive learning as an architectural device. A comparative analysis of three international precedents completes this framework and grounds the identification of the research gap that justifies the design proposition of subsequent research phases.

The contribution of this review is threefold. It articulates, within a single operative framework, bodies of knowledge usually treated separately, sustainable construction, environmental science and experiential pedagogy. It identifies, through a critical reading of existing pedagogical and ecological parks, the precise gap that a new generation of facilities must fill. And it establishes the theoretical principles that will govern the design of an immersive pedagogical park adapted to a tropical context, using Cameroon as an illustrative case.

II. SUSTAINABLE ARCHITECTURE: FOUNDATIONS AND OPERATIONAL PRINCIPLES

➢ *Definition and Evolution of the Concept*

Sustainable architecture cannot be reduced to a technical response to energy crises; it embodies a deep transformation of constructive thought, marking the shift from an architecture of consumption to an architecture of management and regeneration. The emergence of sustainability in architecture is rooted in the environmental awareness of the 1970s, but it is the 1987 Brundtland Report that gave the concept of sustainable development its international legitimacy, articulating the economic, social and environmental dimensions of a development capable of meeting present needs without compromising those of future generations. In the architectural field, this framework has produced a shift from a corrective logic, polluting less, to a proactive logic, building better, encompassing the full life cycle of the building: material extraction, design, construction, use, maintenance and, where applicable, deconstruction or reversibility.

More than a set of technical prescriptions, sustainable architecture thus asserts itself as a genuine design philosophy, questioning the relationship between the individual, the built environment and the biosphere. It implies a constant dialogue between the functionality of spaces, social uses and the preservation of natural balances, integrating climatic, cultural and territorial considerations specific to each context.

➢ *Fields of Application*

The application of sustainability in architecture extends to the whole set of components of the architectural project, from initial conceptual choices to constructive detailing and long-term operational strategies. Material selection and life-cycle thinking constitute one of the central fields of application, privileging natural, local and renewable resources such as wood, stone or earth in order to reduce the embodied energy associated with extraction, transformation and transport.

Fig 1 Life Cycle of Bio-Sourced Materials.
Source: Boisdellys, 2022.

A second fundamental field concerns bioclimatic and energy-conscious design. Sustainable architecture prioritizes passive strategies that exploit locally available natural resources, orientation, opening layout and volumetric compactness, before resorting to mechanical systems, in order to maximize natural lighting, ventilation and thermal comfort. These passive devices are complemented by the reasoned integration of active technologies such as photovoltaic panels, aiming to reduce dependence on fossil energy.

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Fig 2 Bioclimatic Architecture and Renewable Energy Integration.
Source: RDV Immobilier, 2025.

Finally, the field of application of sustainability extends beyond the physical limits of the building to encompass landscape design, resource management and the urban scale. Sustainable architecture includes the preservation of local biodiversity, ecological continuity and the intelligent management of water flows, positioning the building as a constitutive cell of the resilient city of tomorrow rather than a mere consumer of resources.

➢ *The Pillars of Sustainable Architecture*

The operationalization of sustainability in architecture rests on an inseparable tripod: energy performance, material ethics and sobriety in flow management. For a pedagogical park project, these pillars are not only technical objectives but become real-time demonstration tools for the user.

- *Energy Efficiency and Bioclimatic Design:*

Energy efficiency constitutes one of the major levers for reducing the carbon footprint of the building sector, which is responsible for a significant share of global energy consumption and greenhouse gas emissions. It relies primarily on a bioclimatic approach, exploiting the natural characteristics of the site, climate, sunlight, dominant winds, topography and vegetation, to ensure thermal, visual and hygrothermal comfort without excessive recourse to energy-intensive mechanical systems. In humid tropical contexts such as Yaounde, this question is particularly critical: architecture must reconcile solar protection, natural ventilation and humidity control through adjustable sunshades, roof overhangs, ventilated facades and vegetated screens.

- *Sustainable and Local Materials:*

The choice of materials constitutes a central issue in sustainable architecture, as it directly conditions the embodied energy of the project. This invisible energy often represents a significant share of the overall environmental footprint of the building, frequently underestimated in favor of operational energy performance alone. Several emblematic materials illustrate this local and sustainable approach: stone, an ancestral material with high thermal inertia favorable to natural temperature regulation; wood, a renewable resource with low carbon impact when sourced from sustainably managed supply chains; raw earth, in its various forms, whose hygrothermal properties naturally regulate indoor humidity and temperature; hemp, a bio-based material with significant carbon storage capacity; recycled cellulose wadding, illustrating a circular approach in which waste becomes resource; and straw, a renewable and abundant agricultural by-product with very low embodied energy and excellent thermal performance.

Fig 3 Construction Timber, a Renewable and Low-Carbon Local Material.
Source: Martin Inside, November 2016.

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- *Resource Management:*

Beyond materials and energy, sustainable architecture integrates a systemic dimension of resource management, water, biodiversity and material flows, whose mechanisms can be rendered visible and intelligible, reinforcing their pedagogical value and their role in raising awareness. The fundamental objective of this management is to restore a durable balance between human activity and nature, in which human needs no longer operate at the expense of ecosystems. This approach contributes to improving the quality of life of users by offering healthier, more resilient spaces in greater harmony with their surrounding environment.

III. CONTEMPORARY ENVIRONMENTAL CHALLENGES AND THE RESPONSIBILITY OF DESIGN DISCIPLINES

➢ *Definition and Typology of Environmental Challenges*

Contemporary environmental challenges designate the set of disturbances and imbalances affecting natural systems under the combined effect of natural dynamics and, predominantly, human activities. These challenges are characterized by their global scope, their systemic complexity and their direct impact on the living conditions of human societies, and must be understood through an integrated approach accounting for the interactions between environment, society and territory [3], [12]. They encompass, among others, climate change, ecosystem degradation and the pressures exerted by urbanization and anthropogenic activities.

Climate change is defined as a durable modification of the state of the climate, identifiable through variations in the mean or variability of its properties and persisting over long periods. Reports on the subject establish a direct link between these transformations and the rise of anthropogenic greenhouse gas emissions, notably linked to energy production, transportation, industry and the building sector [2]. Beyond its physical impacts, climate change poses a cognitive and pedagogical challenge: its global nature, often perceived as abstract, limits its appropriation by populations, underscoring the need for educational devices capable of making climatic issues perceptible through concrete, situated experiences.

Fig 4 Impacts of Climate Change on Ecosystems and Territories.
Source: Conso Globe, 2025.

Ecosystem degradation refers to the progressive or abrupt alteration of the capacity of natural systems to perform their essential ecological functions and to provide the ecosystem services indispensable to human societies. The Millennium Ecosystem Assessment shows that more than sixty percent of global ecosystem services are today degraded or unsustainably exploited [4], underlining the systemic character of this crisis. Its causes are largely attributable to human activity, including deforestation, soil sealing, pollution and the overexploitation of resources; landscape fragmentation in particular weakens ecosystem resilience [5], while rapid landscape transformations induced by anthropogenic pressure durably alter ecological balances at multiple spatial and temporal scales [6].

Urban and anthropogenic pressures designate the set of constraints exerted by human activities on natural and built environments, closely linked to demographic growth, rapid urbanization and the evolution of consumption patterns. More than half of the world population today lives in urban areas, a proportion expected to reach nearly seventy percent by 2050 [8]. Dominant urban models, characterized by sprawl and automobile dependence, contribute significantly to the increase of the ecological footprint of cities [7], while the standardization of urban landscapes and the reduction of accessible natural spaces contribute to a progressive estrangement of citizens from environmental issues [9].

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Fig 5 Urban Congestion and Anthropogenic Pressure on the Built Environment.
Source: Actu Cameroun, 2019.

➢ *Territorial, Social, Economic and Cultural Impacts*

These environmental challenges exert a profound influence on the evolution of urban and natural spaces, affecting the availability of resources and the capacity of environments to absorb disturbances, and accentuating the vulnerability of urban and peri-urban territories where the concentration of population and infrastructure amplifies the effects of climatic hazards. Beyond their physical dimension, these impacts extend deeply into the social, economic and cultural spheres. The most vulnerable populations are often the most exposed to environmental risks, revealing marked territorial and social inequalities, while the loss of landscape references and the scarcity of accessible natural environments contribute to a progressive estrangement between individuals and nature [9], [10], weakening environmental consciousness and limiting the collective appropriation of ecological issues.

➢ *Architecture's Responsibility and the Limits of Sectoral Approaches*

Faced with the scale of these challenges, the design disciplines occupy a central place in the reflection on the transformation of territories. Architecture in particular intervenes directly on built forms, the uses of space and the interactions between natural and constructed environments, constituting a strategic tool for rethinking how humans inhabit and transform their environment. The building sector represents a significant share of global greenhouse gas emissions, energy consumption and natural resource exploitation [1], conferring on architecture a particular responsibility in the integration of environmental issues, notably through bioclimatic design, the use of local materials and the reduction of the ecological footprint of urban development.

Despite this growing recognition, the responses provided by the design disciplines often remain fragmented and sectoral, dissociating the environmental, social and spatial dimensions in favor of isolated technical or regulatory solutions [11], [13]. This sectoral logic frequently results in an excessive focus on energy performance or the implementation of technological devices, to the detriment of a global reflection on uses, spatial experience and quality of life, at the risk of reducing architecture to a mere instrument of regulatory compliance rather than a vector of behavioral change [13]. This limitation reveals the urgent need to renew the conceptual frameworks of design, integrating forms of spatial mediation capable of favoring a holistic and sensitive understanding of environmental issues, a transition for which immersive learning offers a promising theoretical foundation.

IV. IMMERSIVE LEARNING: A THEORETICAL FRAMEWORK FOR EXPERIENTIAL ARCHITECTURE

➢ *The Concept of Immersion in Architecture*

In architecture, immersion is defined by the capacity of an environment to absorb the attention of the user and to engage the whole of their sensory system, aiming to create a rupture with the everyday and to establish a state of heightened presence [15].

- *Sensory Immersion:*

Sensory immersion rests on the simultaneous and multimodal solicitation of the senses, going beyond the visual perception often privileged by conventional, ocular-centric architecture. A phenomenological approach considers spatial perception as bodily and holistic, mobilizing sight, hearing, touch and smell [14]. Architecture must be apprehended by the whole body rather than by the gaze alone; tactile variations of ground materials, thermal modulation created by shaded areas and water bodies, and acoustic scenography together transform each itinerary into multimodal, immersive learning. Materiality thereby becomes a genuine vector of presence and awareness, as one only fully protects and understands what one has touched, felt and experienced directly.

- *Cognitive and Emotional Immersion:*

Beyond sensory experience, spatial and architectural immersion must mobilize the cognitive and emotional spheres to guarantee durable and meaningful learning. The state of

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flow constitutes a central mechanism of this cognitive immersion: a successful immersion induces a state of deep concentration in which the perception of time and space is altered, allowing complete absorption in the activity [16]. In a pedagogical park project, this translates into itineraries designed to minimize urban distractions and maximize attention to observable natural phenomena, decomposition cycles, pollination, vegetal growth or hydrological variations, reinforcing intuitive understanding and the memorization of environmental processes. Neuroscience applied to architecture further demonstrates that emotionally marked experiences are better memorized and integrated over the long term, an emotional anchoring that immersive architecture exploits through contrasts of light, shadow and scale.

Fig 6 Cognitive and Emotional Immersion in Pedagogical Architecture.
Source: Custom Technologies Design Lab, August 2024.

➢ *Spatial Devices Supporting Immersive Learning*

- *Path, Scenography and Spatial Narrative:*

Contemporary literature increasingly recognizes the capacity of architectural space to function as a narrative device, in which the itinerary conditions how the user perceives, understands and memorizes spatial content. In a pedagogical park, the itinerary thus becomes a genuine didactic tool, allowing knowledge to be hierarchized and accompanying the learner through a gradual and coherent reading of the themes addressed. However, an excessively directive scenography tends to freeze uses and to transform the user into a mere spectator of a preconceived discourse, reducing their capacity for appropriation and personal interpretation [21]. Conversely, rhizomatic models of spatial organization, founded on multiplicity and free exploration, open the way to non-linear itineraries favoring fortuitous discovery and experiential learning, though at the risk of undermining pedagogical legibility [22]. The scientific gap identified in the literature lies precisely in the difficulty of articulating a narrative structure coherent enough to sustain learning while leaving the user a margin of exploration and personal appropriation.

- *Interaction, Perception and Experimentation:*

On the pedagogical level, immersive spatial devices align with constructivist theories according to which knowledge is built through action and direct experience, and find an extension in the experiential learning model, which underscores that knowledge acquisition rests on a dynamic cycle alternating concrete experience, reflective observation, conceptualization and active experimentation [17]. The concept of affordance allows these spaces to be interpreted as inciting environments, whose physical properties spontaneously suggest uses: touching a material, manipulating water, or feeling the thermal inertia of a wall becomes an implicit act of learning, without explicit didactic mediation [18]. This aligns with the understanding that a stimulating and interactive context enables the learner to progress when placed in a milieu rich in opportunities for observation, action and experimentation [19], [20]. Yet a recurrent limitation of contemporary pedagogical devices lies in their often-abstract character, detached from the physical reality of the phenomena studied, leaving a gap between theoretical knowledge and lived experience.

➢ *Experiential Learning and Environmental Awareness*

The acquisition of ecological consciousness cannot be limited to the theoretical transmission of factual data; education for sustainable development must be transformative and involve a questioning of behavior [23]. Cognitive science applied to architecture shows that memorization is not solely an abstract intellectual process but is closely tied to emotion, the body and the spatial context in which information is perceived. Pedagogical architecture therefore exceeds the function of a visual or textual support: it becomes a full-fledged pedagogical medium, capable of proposing non-verbalized learning situations in which sensitization is transformed into durable environmental comprehension, making the user not a mere observer but an engaged actor of their own learning.

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V. THE IMMERSIVE PEDAGOGICAL PARK AS AN ARCHITECTURAL PROGRAM

➢ *Definition and Typology of Pedagogical Parks*

A pedagogical park is a planned landscaped and architectural space designed to facilitate learning through direct contact with specific themes, science, nature or history. Its pedagogical effectiveness rests on the legibility of its spatial structure, allowing the user to orient themselves and assimilate information intuitively [24]. Classical educational parks, often associated with academic institutions and functioning as outdoor classrooms, tend to privilege didactic transmission at the expense of sensory and immersive experience [28], generating a spatial rigidity that can limit their appeal and reduce the appropriation of knowledge to a superficial level [25].

Theme parks, by contrast, rely on a scenographic approach in which architecture, landscape and playful devices work together to orient attention and provoke emotion, reinforcing memorization of the messages conveyed [26]. Ecoparks, a more recent typology centered on sustainability and ecological conservation, constitute essential levers for reconnecting urban populations with nature and promoting biodiversity [8], though they often prioritize ecological engineering over the immersive and sensorial architectural dimension, which can reduce visitors' emotional engagement. It is precisely at this intersection, fusing the codes of theme parks, narrative, emotion, free exploration, with the educational and ecological objectives of the ecoparks, that the concept of the immersive pedagogical park is positioned, transforming the space into an active pedagogical tool in which the user experiences, feels and understands ecological processes rather than merely observing them.

➢ *Pedagogical, Social and Environmental Functions*

- *Knowledge Transmission:*

The primary function of the pedagogical park is to render tangible the learning of complex concepts through space and experience, offering a pedagogy of evidence in which knowledge manifests directly through the environment. Vegetated roofs can illustrate water cycles and thermal regulation, pedagogical basins can demonstrate rainwater infiltration and retention, and biodiversity trails can reveal the dynamics of local ecosystems, favoring multisensory and immersive learning. However, this transmission can fail if the space becomes overly museum-like or overly didactic, reducing spontaneous interaction and individual curiosity; the challenge consists in designing an architecture that speaks for itself, combining legibility, intelligibility and flexibility of itineraries.

- *Social Function:*

Beyond its individual dimension, the pedagogical park fulfills a major social function as a public space. Drawing on the notion of the third place, situated between home and school, it offers a neutral setting conducive to exchange and encounter, transforming the park into a catalyst for intergenerational dialogue [27]. A frequently identified limitation, however, concerns accessibility and inclusivity: some parks remain perceived as elitist or reserved for initiated audiences, limiting the social and environmental impact of the approach [8]. The architectural and social challenge therefore consists in designing an open and welcoming park, integrating the diversity of ages, abilities and social origins, in coherence with the objective of inclusive and sustainable public spaces.

Fig 7 Environmental Education and Sustainable Development in Public Parks.
Source: Programme Des Parcs Nationaux De France, 2021.

- *Environmental Function:*

The environmental function of the pedagogical park is no longer limited to the preservation of green spaces but is inscribed within a dynamic of urban regeneration. In a context marked by climate disruption and accelerated urbanization, the park participates actively in the resilience of urban ecosystems by integrating nature-based solutions, recognized as essential levers for mitigating heat-island effects and improving

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hydrological risk management [2]. At the local scale, the park acts as a microclimatic regulator through stratified vegetation and controlled water cycle management, while at the territorial scale, its efficacy depends on its capacity to inscribe itself within ecological continuities rather than remaining an isolated fragment [8].

➢ *Limits and Potential of Existing Instructive Parks*

The analysis of pedagogical parks reveals that an illustrative approach, in which architecture and landscape mainly serve as support for dense signage or digital interactive devices, still dominates many educational spaces. Although this approach allows targeted information transmission, cognitive overload can limit directed attention and reduce memorial impact [29]; learning then becomes superficial, as the user reads, sees or hears information without integrating it into a lived and meaningful experience. Conversely, the spectacular approach, typical of theme parks and some private ecoparks, relies on visual wonder and entertainment to capture visitor attention [26]; while such devices succeed in provoking immediate emotional engagement, they struggle to generate deep learning, producing memorable but rarely transformative experiences in which the visitor admires biodiversity or water management systems without understanding their functioning or their impact on the broader ecosystem.

The literature thus identifies a structural deficit in the design of pedagogical parks: the difficulty of combining attractiveness, sensory immersion and scientific rigor. This gap resides precisely in the absence of integrated devices allowing the user to experiment, manipulate and reflect on ecological complexity while remaining guided by a coherent spatial narrative, a limitation that justifies the necessity of the immersive pedagogical park, capable of transforming space into an active instructional tool in which architecture, landscape and narrative become vectors of learning and deep environmental awareness.

➢ *Implications for Architectural Design*

Three major architectural challenges emerge from this analysis. First, technical transparency, rendering visible and intelligible the cycles of energy and matter, water management, energy flows, waste treatment or bio-sourced materials, favoring implicit and experiential learning. Second, immersive scenography, in which the architect orchestrates sensory atmospheres, variations of light, acoustic contrasts, microclimates and textures, to induce a state of pedagogical and emotional receptivity. Third, evolutivity, requiring spatial devices designed to adapt to future advances in ecological science and to new pedagogical practices, through modular structures and reversible interactive supports [30]. In Cameroon, although the network of national parks and botanical gardens constitutes an exceptional heritage foundation, their pedagogical exploitation faces structural realities that limit their transformative reach, justifying the analysis of international precedents capable of informing a locally adapted model.

VI. INTERNATIONAL PRECEDENTS: A COMPARATIVE ANALYSIS

➢ *Eden Project (United Kingdom)*

Inaugurated in 2001 in the United Kingdom, the Eden Project transformed a degraded industrial site, a former kaolin quarry of nearly fifteen hectares in Cornwall, into a living manifesto of sustainable development. Designed by Nicholas Grimshaw, the project rests on an innovative structure combining advanced engineering and formal lightness: two large bioclimatic greenhouses, called biomes, house distinct climatic ecosystems, tropical rainforest and Mediterranean, complemented by a central building, The Core, dedicated to interpretation and education. The geodesic biomes, covered with ETFE cushions, achieve very large spans with a minimal quantity of material while offering maximal transparency, reinforcing the visual and sensory relationship with vegetation.

Fig 8 Aerial View of the Eden Project, United Kingdom.
Source: Wikipedia, 2001.

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Beyond its spectacular architectural dimension, the Eden Project functions as a large-scale device of environmental mediation, articulating architecture, pedagogy and landscape in an integrated approach where the spatial itinerary, the staging of living organisms and the legibility of technical devices contribute to an immersive learning experience. The organization of the project is deeply conditioned by the singular topography of the former quarry: a descending itinerary constitutes the first sequence of the architectural experience, acting as a device of distancing from the outside world comparable to a rite of transition, before the visitor progressively discovers the biomes, whose non-linear internal circulation favors learning through discovery, in accordance with the theories of experiential learning and constructivism [17], [19], [20].

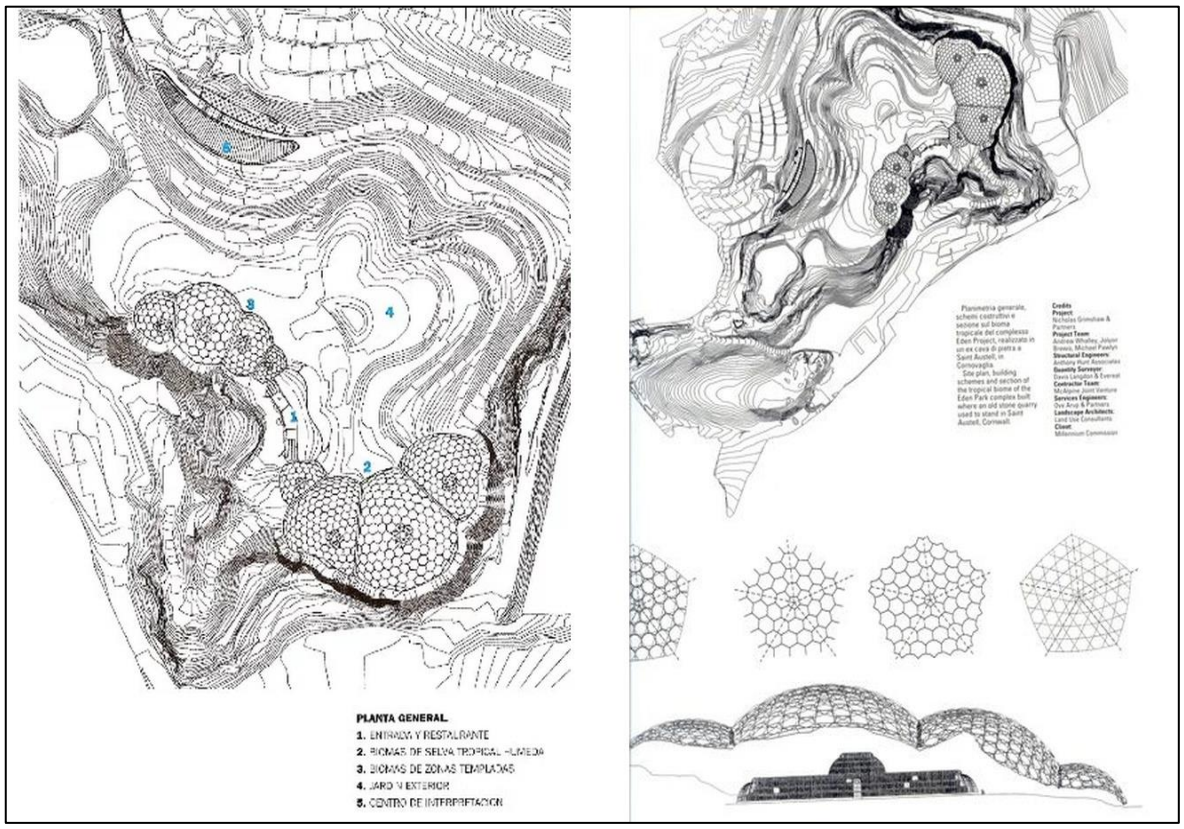

Fig 9 Site Plan of the Eden Project.
Source: Wikipedia, 2001.

➢ *Dino's Park (France)*

Located in Saint-Hilaire-de-Riez in the Vendee region of France, Dino's Park constitutes a particular typology of cultural and educational facilities with a playful vocation, founded on the outdoor staging of life-size reconstructions of dinosaurs and prehistoric species along a visitor path. Unlike traditional natural history museums, founded on indoor museographic devices and authentic objects, this typology privileges an immersive approach based on reproduction and visual narration, with built architecture generally reduced to reception and service structures, leaving the landscape to play a central role in the visitor experience.

The declared mission of Dino's Park is the popularization of scientific knowledge related to paleontology and the history of life on Earth, transmitted essentially through visual and sensory experience, structured around a chronological linear itinerary punctuated by interaction stations where the linearity is deliberately interrupted to allow for simulated excavation zones and participatory workshops. This clarity reduces the visitor's cognitive load but can, conversely, limit the freedom of spatial appropriation and more personal exploration of the site, an emphasis on wonder and curiosity that raises the recurring question of the depth and durability of the knowledge transmitted.

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Fig 10 Visitor Guide and Itinerary of Dino's Park.
Source: Dino's Park, 2026.

➢ *Ludogaia (France)*

Established in a deliberately preserved natural environment in the municipality of Vezeronce-Curtin, in the Isere department of France, Ludogaia is inscribed in an approach of ecological mediation founded on immersion and experimentation, exploiting the landscape qualities of the site to create a continuity between pedagogical devices and existing ecosystems. Addressing primarily a young and family public, the park favors light, reversible structures with low environmental impact, an architectural humility that reinforces perceptual continuity between the natural milieu and the constructed devices, avoiding any symbolic rupture between humans and their environment.

Fig 11 Interactive Map of Ludogaia.
Source: Ludogaia, 2024.

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Contrary to the traditional zoo model, founded on the exhibition of animals as objects of contemplation, Ludogaia privileges a systemic approach to living organisms, emphasizing biological mechanisms and ecological balances rather than the spectacular presence of fauna. Its pedagogical finality rests on learning through the body and kinesthetic experience, transforming abstract ecological notions into lived situations through sensory itineraries, large-scale games and manipulable devices, an organic and sensitive immersion that invites the user to mobilize their senses and to reconnect with an intuitive, bodily relationship with the living world.

VII. DISCUSSION: TOWARD A TROPICAL MODEL OF THE IMMERSIVE PEDAGOGICAL PARK

➢ *Synthesis and Research Gap*

The confrontation of the theoretical literature with the analysis of the Eden Project, Dino's Park and Ludogaia reveals that sustainable architecture has crossed a decisive threshold, moving from a logic of energy performance to an ambition of social and environmental sensitization. However, this synthesis also highlights a major contradiction in the current literature: while the need to reconnect humans with their environment is unanimously recognized by international bodies, architectural responses still oscillate too often between a hermetic technicality and a purely illustrative scenography. There exists a persistent gap between pedagogical intention and the sensory reality of the spaces created, and none of the precedents examined fully reconciles didactic rigor with openness to local microclimatic realities, particularly within tropical contexts.

➢ *Four Founding Principles*

This critical reading allows four founding principles to be established for the design of an immersive pedagogical park. Sensory engagement, mobilizing the full range of senses through materiality, thermal modulation and acoustic scenography, rather than a purely visual or informational reading. Spatial narrative, in which the itinerary structures a coherent progression while preserving a margin of exploration and personal appropriation, avoiding both excessive linearity and dispersive absence of structure. Experiential transmission, in which architecture becomes the medium of the ecological phenomenon itself, rather than a simple support for signage, transforming manipulation and direct observation into durable understanding. And environmental performance, in which the building operates as a visible and legible demonstrator of the bioclimatic and material principles it embodies, so that the pedagogical park is itself a living exhibit of sustainable architecture.

➢ *Implications for the Cameroonian Context*

Applied to the Cameroonian context, and to the humid tropical climate of Yaounde in particular, these principles imply an architecture that reconciles solar protection, natural ventilation and humidity control with an immersive, non-linear spatial narrative rooted in locally available bio-sourced materials, earth, wood, bamboo and fibers, whose tactile and thermal qualities can themselves become pedagogical content. They further imply an inclusive social program, open to a plural public, and an environmental function conceived as an active contribution to urban ecological continuities rather than an isolated green enclave. This theoretical and comparative framework thus establishes the conceptual foundation upon which the architectural design proposition of the immersive pedagogical park, as a device of sensitization and environmental reconnection, can be built.

VIII. CONCLUSION

This article has established a systematic literature review articulating the theoretical and technical foundations of sustainable architecture, the typology and territorial implications of contemporary environmental challenges, and the theoretical framework of immersive and experiential learning as an architectural principle. The comparative analysis of three international precedents, the Eden Project, Dino's Park and Ludogaia, demonstrates that immersive spatial devices can operationalize environmental sensitization with significant pedagogical and emotional effects, while also revealing the persistent difficulty of reconciling scientific rigor, sensory immersion and contextual relevance.

The four principles identified, sensory engagement, spatial narrative, experiential transmission and environmental performance, provide a rigorous and transposable foundation for the design of an immersive pedagogical park, particularly within tropical contexts such as Cameroon, where the network of natural heritage remains underexploited from a pedagogical standpoint. Architecture alone cannot resolve the environmental crisis, but it can create the spatial conditions through which users experience, understand and durably appropriate the ecological challenges of their territory. This is the theoretical foundation upon which the subsequent design phase of this research is built.

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