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Municipalities as learning ecosystems: Integrating local climate action into climate change education in Ankara, Türkiye

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Abstract

Climate change education is commonly organized through schools, yet many of the infrastructures, decisions, and public encounters through which residents learn about climate change are governed locally. Municipalities may therefore function not only as service providers but also as learning ecosystems. This study examines how local climate action can be translated into climate change education through a document-based case study of Ankara Metropolitan Municipality (AMM), Türkiye. Eleven publicly available municipal and intergovernmental documents and webpages published between 2022 and 2026 were analysed using qualitative document analysis and abductive thematic coding. The analysis combined climate change education principles, learning-city scholarship and urban climate governance research. Five mutually reinforcing dimensions were identified: policy-to-pedagogy translation, place-based practice, partnership brokerage, participation and agency, and evidence and feedback. Ankara demonstrates substantial assets across these dimensions, including formal climate plans, municipal lifelong-learning spaces, teacher education partnerships, youth and children's participation structures, and operational sites that can serve as living laboratories. However, these assets remain only partly connected: educational objectives are not consistently embedded in climate plans, participation mechanisms are not systematically linked to implementation cycles, and evaluation largely records activities rather than learning, agency, or climate-action outcomes. The proposed Municipal Climate Learning Ecosystem Framework explains how municipalities can connect governance, public services, and education without turning climate learning into a stand-alone awareness campaign. It offers a transferable planning and evaluation tool for cities seeking to align climate action with lifelong learning.

Keywords: Ankara, Climate change education, Learning cities, Lifelong learning, Municipal governance.

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Contribution of this paper to the literature

This study develops the Municipal Climate Learning Ecosystem Framework from Ankara's public documents, integrating climate education, learning cities, and urban climate governance. It extends conventional awareness approaches by connecting municipal policy, infrastructure, and partnerships with civic agency and institutional feedback, offering a framework for planning and evaluating climate learning.

1. Introduction

Climate change is at once a scientific, political, and educational challenge. As the Intergovernmental Panel on Climate Change has stressed, effective mitigation and adaptation depend not only on new technologies and infrastructure but also on changes in institutions, everyday practices, and participation [1]. Education matters in this process because it influences how people interpret risk, imagine possible futures, weigh competing priorities, and act collectively. Recent international guidance therefore treats climate change education as a lifelong, society-wide endeavour rather than as content belonging to a single school subject [2].

Even so, climate education research still concentrates largely on formal schooling. Schools and teachers are indispensable, but classrooms are only one of the places where climate learning takes place. Residents encounter climate policy while using public transport, managing waste and water, visiting parks, engaging with urban agriculture or emergency planning, attending community centres, and participating in municipal consultations. These encounters may remain isolated pieces of information. When they are designed with educational intent, however, they can foster knowledge, critical judgment, collective efficacy, and action competence. Local institutions play a decisive role in determining which of these possibilities are realized.

Municipalities are therefore situated at a productive intersection between climate governance and education. Their authority, service infrastructure, public facilities, neighbourhood presence, purchasing power, and capacity to convene different actors give them educational possibilities that are rarely considered together. They can link schools to civil society, universities, professional associations, and the departments responsible for urban operations, while translating national and international commitments into decisions that are meaningful in a particular place. Research on urban climate governance already treats cities as settings for experimentation, coordination, and learning [3-5]. Climate education studies likewise show the value of locally relevant, participatory, and action-oriented approaches [6-9]. Yet the two literatures seldom meet: governance studies generally discuss organizational or policy learning, whereas education research usually focuses on students or individual citizens. As a result, the municipality itself remains underdeveloped as a unit of educational analysis.

Ankara provides a useful case for examining this gap. The city combines formal climate-planning instruments and a dedicated Department of Climate Change and Zero Waste with lifelong-learning centres, youth facilities, environmental education partnerships, and established participation bodies. Its admission to the UNESCO Global Network of Learning Cities (GNLC) in December 2025 created a visible institutional connection between local governance and lifelong learning [10, 11]. This combination is relevant beyond Ankara, particularly for expanding metropolitan areas where climate action and education are often planned on separate administrative tracks.

Against this background, the study addresses three questions: (1) Which institutional arrangements in Ankara create opportunities for climate learning? (2) Where do gaps persist among climate governance, education, and participation? (3) What kind of transferable framework could help municipalities organize climate action as a learning ecosystem? The analysis draws on a purposively selected body of public documents and develops the Municipal Climate Learning Ecosystem Framework (MCLEF). Its contribution is both conceptual and practical: municipal climate action is examined as a form of educational infrastructure, and the resulting dimensions can be used in planning, coordination, and evaluation.

2. Conceptual Grounding

2.1. Climate Change Education Beyond Information

Climate change education has moved from a predominantly knowledge-deficit model toward approaches that combine knowledge with values, emotions, participation, and action. Stevenson, et al. [6] describe climate change education as a field shaped by the relationships among science, policy and educational purpose Stevenson, et al. [6]. Mochizuki and Bryan [7] argue that education for sustainable development can provide an integrative frame because climate change requires attention to ecological processes, social structures, justice and local-global interdependence [7]. A systematic review by Monroe and colleagues found that effective programmes make climate change personally meaningful and use active, deliberative and engaging pedagogies [8].

This shift is reinforced by action-competence theory. Jensen and Schnack [9] distinguish educational activity that merely prescribes desirable behaviour from learning that enables people to understand conflicting interests, form reasoned judgments and take intentional action [9]. Climate learning is therefore not demonstrated solely by remembering facts or adopting isolated habits. It also involves the capacity to participate in collective decisions and to influence the systems that shape emissions and vulnerability. Rousell and Cutter-Mackenzie-Knowles [12] similarly call for approaches that give children and young people both a 'voice' and a 'hand' in responding to climate change [12].

Holistic models also identify affective and future-oriented dimensions. Cantell, et al. [13] bicycle model integrates knowledge, thinking skills, identity, values, motivation, hope, emotions, participation and operational barriers [13]. These dimensions are particularly important in a municipal context because local climate policy is encountered through tangible places and contested choices. A drought strategy, cycling network or waste facility can become a site for inquiry into evidence, equity, responsibility and alternatives. Municipal action can thus support the movement from abstract global concern to situated and collective agency.

2.2. Learning Cities and Municipal Climate Governance

The learning-city perspective extends education across the life course and across urban settings. UNESCO defines a learning city as one that mobilizes resources across sectors, revitalizes learning in families and

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communities, facilitates learning for and in the workplace, uses modern learning technologies, enhances quality and nurtures a culture of learning throughout life [14]. Learning cities connect Sustainable Development Goal (SDG) 4 on education with SDG 11 on inclusive, safe, resilient and sustainable cities. The concept is therefore inherently institutional: it depends on coordination among local authorities, educational organizations, communities and employers rather than on the expansion of formal schooling alone.

Recent work makes climate action more explicit within this agenda. The 2024 Jubail Commitment calls on learning cities to align education policies with local climate action and to mobilize lifelong learning for behavioural, occupational and community transformation UNESCO Institute for Lifelong Learning [15]. Piazza [16] emphasizes collaborative partnerships as a defining mechanism through which learning cities can advance sustainable urban development [16]. This partnership logic matters because municipalities seldom control curricula, universities, civil-society organizations, or professional development systems, yet they can broker relationships among them and provide problems, places, and data around which learning is organized.

Urban climate governance scholarship offers a complementary account of learning. Wolfram, et al. [3] distinguish multiple forms of learning in urban climate governance, including learning about problems, instruments, institutional arrangements and deeper frames of reference Wolfram, et al. [3]. van der Heijden [4] review shows that urban climate action depends on configurations of actors, authority and context rather than on isolated municipal programmes [4]. More recent case research demonstrates that innovative projects do not automatically produce wider change; learning must be deliberately captured, circulated and embedded in routine governance [5]. These insights imply that a municipal learning ecosystem needs feedback mechanisms that connect public learning and institutional learning.

2.3. Defining a Municipal Climate Learning Ecosystem

In this study, a municipal climate learning ecosystem refers to the connected policies, places, programmes, partnerships, and participation mechanisms through which a municipality helps people and institutions understand climate risks, practise responses, influence decisions, and learn from evidence. The word 'ecosystem' is used deliberately. The presence of a teacher workshop, a youth council, a climate plan, and a waste facility in the same city does not by itself create a coherent system. These elements begin to function as an ecosystem when their objectives, learning pathways, and feedback processes are intentionally connected.

This definition also distinguishes three levels of learning. Individual learning includes changes in knowledge, skills, values, efficacy, and practice. Collective learning occurs when groups deliberate, co-produce solutions, and develop shared capacity. Institutional learning occurs when evidence and experience modify municipal routines, priorities, or resource allocation. A robust municipal climate learning ecosystem links all three. It gives residents access to knowledge, gives communities meaningful roles, and gives institutions mechanisms to respond to what is learned.

3. Methodology

3.1. Research Design and Case Selection

This exploratory qualitative case study is based on the analysis of public documents. The method is suited to a research problem concerned with formal commitments, institutional arrangements, and the links among policy, programmes, and public communication [17]. Ankara was treated as a single instrumental case: the aim was to refine a concept that may be useful elsewhere, not to claim statistical representativeness. The case was selected because the city brings together metropolitan climate-planning responsibilities, a dedicated municipal climate unit, several education and participation infrastructures, and recent recognition as a UNESCO Learning City. This institutional combination makes it possible to examine climate governance and lifelong learning within the same local setting.

The unit of analysis was not a single programme. It was the municipal configuration through which climate-related knowledge, participation and practice are organized. The temporal boundary was 2022-2026, beginning with the public availability of Ankara's comprehensive local climate change action plan and extending through the city's entry into the GNLC and subsequent ecological-literacy activities. Earlier material was included only when it described a participation structure still visible in the current system.

3.2. Corpus and Data Collection

Eleven publicly accessible sources from AMM and UNESCO were purposively selected. A source was included if it defined municipal climate commitments, documented an environmental or climate-education activity, described a mechanism for youth or child participation, or connected Ankara to the learning-city framework. Publicity items that gave no information about objectives, actors, or implementation were excluded. Table 1 summarizes the final corpus. The webpages were last checked on 19 August 2026.

Table 1. Document corpus.

Code	Source	Date	Analytical contribution
D1	AMM climate change action plan	2022	Climate risks, emissions, adaptation and municipal actions
D2	AMM Responsibility report 2024-2025	2026	Institutional structure, plans, training and participation activities
D3	UNESCO announcement of new GNLC members	2025	External recognition and learning-city rationale
D4	UNESCO learning city profile: Ankara	2026	Links among climate action, lifelong learning and municipal services
D5	AMM announcement of GNLC membership	2025	Local framing of learning-city membership
D6	AMM-TÜRÇEV education project page	2025-2026	School, youth and public environmental education partnership

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D7	Ecological literacy training for teachers	2026	Teacher development and experiential learning intentions
D8	AMM 2025-2029 youth strategy meeting	2024	Youth inclusion in strategic planning
D9	Ankara City Council youth assembly meeting	2022	Climate ambassadors and ecological awareness
D10	AMM children's assembly decisions	Current archive	Child proposals on waste, green space, water and energy
D11	AMM public reports catalogue	Current archive	Availability of climate and green-city plans

3.3. Analytical Procedure

The analysis involved three stages. First, every source was reviewed for references to learning, training, awareness, participation, partnerships, public facilities, climate action, and evaluation. Initial codes described the actors involved, intended audiences, settings, expected outcomes, and policy links. Second, these codes were considered alongside concepts from climate change education, action competence, learning-city research, and urban climate governance. Moving back and forth between the documents and these theoretical perspectives allowed the categories to remain grounded in the case while being refined through existing scholarship.

In the third stage, the categories were assessed according to their role in the wider municipal system. A category was retained only when it explained how municipal action could generate, connect, or improve learning rather than merely naming a type of programme. This process yielded five dimensions: policy-to-pedagogy translation; place-based practice; partnership brokerage; participation and agency; and evidence and feedback. Attention was also given to weak or missing connections, including activities for which no learning outcomes were reported. A source-by-dimension matrix was used to verify, wherever possible, that interpretations drew on more than one document.

The analysis concerns publicly represented institutional arrangements and should not be read as an impact evaluation. No interviews, observations, or personal data were used. The researcher's practitioner familiarity with municipal climate work supported contextual interpretation but also created a risk of affirmative bias. To reduce this risk, claims were limited to information available in the corpus, distinctions were maintained between documented activities and inferred educational potential, and gaps were reported alongside strengths.

4. Results

4.1. Policy Provides a Strong Climate Mandate but an Incomplete Pedagogical Architecture

Ankara's policy base establishes a substantial mandate for municipal climate learning. The Climate Change Action Plan presents a greenhouse-gas inventory, climate projections, vulnerability analysis, and sectoral measures across buildings, transport, green spaces, water, waste, agriculture, and infrastructure [18]. Its public orientation is educational in a broad sense: it makes the city's climate risks and responsibilities visible and describes awareness as part of municipal capacity. The Responsibility Report further situates climate work within a dedicated department and connects the local climate plan, Sustainable Energy and Climate Action Plan and Green City Action Plan with monitoring, stakeholder coordination and training [19].

Education nevertheless appears mainly as a supporting activity in these documents. The plans identify technical measures and refer to awareness, but they rarely translate sectoral priorities into explicit learning outcomes for particular groups. A water-management measure, for instance, could state what households, facility managers, farmers, or young people should understand and be able to do. A transport measure could identify opportunities to examine accessibility, air quality, and travel choices. At present, this policy-to-pedagogy connection is mostly implicit. Ankara therefore has the substance of a local climate curriculum, its actual risks, systems, and policy choices, but not yet a fully articulated educational architecture.

GNLC membership creates an opportunity to close this gap. UNESCO describes Ankara's climate plan and the training delivered by the Department of Climate Change and Zero Waste at lifelong-learning centres as components of the city's learning profile [11]. This external framing explicitly places climate action inside lifelong learning. However, the municipal climate plans and the learning-city agenda will generate additional value only if their goals, responsible units and indicators are connected rather than reported as parallel achievements.

4.2. Municipal Places and Operations Can Function as Living Laboratories

The corpus shows that Ankara possesses a distributed learning infrastructure. Lifelong-learning centres, Genç Akademi facilities, schools, municipal campuses, parks and operational sites provide settings in which climate knowledge can be tied to practice. The clearest example is the ecological-literacy training organized with the Turkish Environmental Education Foundation (TÜRÇEV). The programme addressed climate change, water conservation, energy efficiency, zero waste, consumption and sustainable living, and combined information with group work and applied activities [20]. Municipal representatives also stated an intention to demonstrate environmental practices on municipal land and campuses, indicating a shift from classroom-only instruction to place-based learning.

The TÜRÇEV cooperation framework extends this logic. Its stated aims include strengthening zero-waste systems in schools, supporting environmental education and expanding activities for children and young people [21]. The municipality is therefore positioned as a broker of access to expertise, sites and implementation experience. A waste-separation system, composting operation, solar installation, urban farm, climate-resilient landscape or public-transport depot can make systems visible in ways that conventional awareness materials cannot. These sites allow learners to examine flows of materials and energy, question operational trade-offs and connect household practices with public infrastructure.

The documents do not indicate that municipal learning sites currently follow a shared educational design. Activities are presented separately, with little evidence of sequenced pathways, reusable materials, or common accessibility criteria. Yet a living laboratory involves more than visiting a facility. Learners need a guiding question, access to relevant evidence, contact with practitioners, structured reflection, and an opportunity to

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propose or test a response. Establishing these elements across sites would turn individual municipal operations into a more coherent learning network.

4.3. Partnerships Expand Reach and Connect Municipal Authority with Educational Expertise

Partnership brokerage is one of the strongest features of the case. The ecological-literacy initiative links AMM's facilities and public mandate with TÜRÇEV's school-based environmental education experience and with teachers who can reach students over time [20, 21]. This relay structure is potentially more durable than municipality-to-public communication because it develops intermediaries. The Responsibility Report likewise presents municipal climate work as a field of coordination with national and international organizations, universities, civil society and other municipal units [19].

The partnership pattern has two educational functions. First, it combines different forms of knowledge: scientific expertise, operational knowledge, pedagogical knowledge and lived local experience. Second, it expands continuity. A municipal department may organize a workshop, but schools, community centres, professional bodies and civic organizations can sustain practice and adapt it to different audiences. Learning-city scholarship identifies precisely this collaborative capacity as a condition for city-wide learning [14, 16, 22].

The principal weakness is that partnerships are represented as projects rather than as a governed portfolio. The documents rarely specify how partners share learning objectives, data, quality standards, or follow-up responsibilities. Without a portfolio view, successful collaborations may remain dependent on individual relationships and funding cycles. A municipal climate learning ecosystem therefore requires a coordination mechanism that maps partners and audiences, reduces duplication, identifies underserved groups, and links each partnership to a climate-policy priority.

4.4. Participation Structures Offer Pathways from Voice to Climate Agency

Ankara has institutional platforms through which children and young people can participate in public life. Youth representatives and volunteers contributed to discussions informing the 2025-2029 strategic planning process [22]. The Ankara City Council Youth Assembly has foregrounded ecological awareness and included the selection of young volunteers as climate ambassadors [23]. The Children's Assembly archive contains proposals concerning visits to environmental facilities, reduced plastic-bag use, recycling infrastructure, green schoolyards, water conservation and solar energy in public buildings [24]. These records demonstrate that young residents do not approach climate-related issues only as recipients of information; they formulate proposals about municipal systems.

This is important because participation can convert climate education into action competence. A proposal, committee discussion or public question requires learners to interpret evidence, consider feasibility, communicate with others and encounter institutional constraints. These are educational experiences even when they are not labelled as lessons. They also produce knowledge for the municipality about priorities, perceptions and barriers.

The documents provide little evidence, however, that proposals from young people and children are routinely linked to climate-plan implementation, departmental responses, or monitoring. When participants cannot see what followed from their contribution, the experience may weaken rather than strengthen their sense of efficacy. A clearer pathway would begin with accessible climate evidence, continue through deliberation and proposal development, require a response from the responsible unit, and allow selected ideas to be piloted. Reporting the results back to participants would complete the cycle and create learning for both residents and the institution.

4.5. Evaluation Remains Activity-Centred

Ankara's climate governance includes monitoring infrastructure, public reporting and international benchmarking. These mechanisms can support learning by making progress and gaps visible. The Responsibility Report documents plans, activities, participation and institutional achievements [19], while the public reports catalogue makes major climate documents accessible [25]. These practices create an evidence base that many municipal education programmes lack.

Evaluation is less developed on the educational side. The documents confirm that trainings, panels, stands, and meetings took place, but they seldom report changes in understanding, skills, agency, institutional practice, or climate-relevant behaviour. Attendance figures are useful measures of reach, yet they do not show whether residents can interpret local climate risks, teachers adopt new approaches, youth proposals affect decisions, or municipal units learn from engagement. This matters because feedback is what turns a collection of activities into a learning system. Without shared outcome measures, it is difficult to compare programmes, improve them, or relate them to climate-policy goals.

The appropriate response is not to reduce learning to short tests or to claim direct emissions effects from every activity. A balanced evaluation model can combine reach, inclusion, learning, agency, action and institutional-response indicators. For example, an ecological-literacy programme could document participant diversity and completion, use pre- and post-tests to assess systems understanding, record classroom or community actions, and examine whether municipal sites or data are subsequently used. A youth participation process could record the proportion of proposals receiving formal responses and the number progressing to pilots. Such measures would make learning visible while respecting its collective and long-term character.

5. The Municipal Climate Learning Ecosystem Framework

The five dimensions identified in Ankara were integrated into the Municipal Climate Learning Ecosystem Framework (MCLEF) shown in Figure 1. The framework is recursive. Policy provides direction and resources; municipal places make climate systems observable; partnerships connect knowledge and audiences; participation turns learning into agency; and evidence feeds experience back into policy. A weakness in any dimension reduces the whole ecosystem's performance. Table 2 summarizes the core municipal function of each MCLEF dimension and provides illustrative indicators for its implementation and evaluation. For example, strong programmes

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without feedback remain episodic, while strong plans without places and participation remain distant from everyday learning.

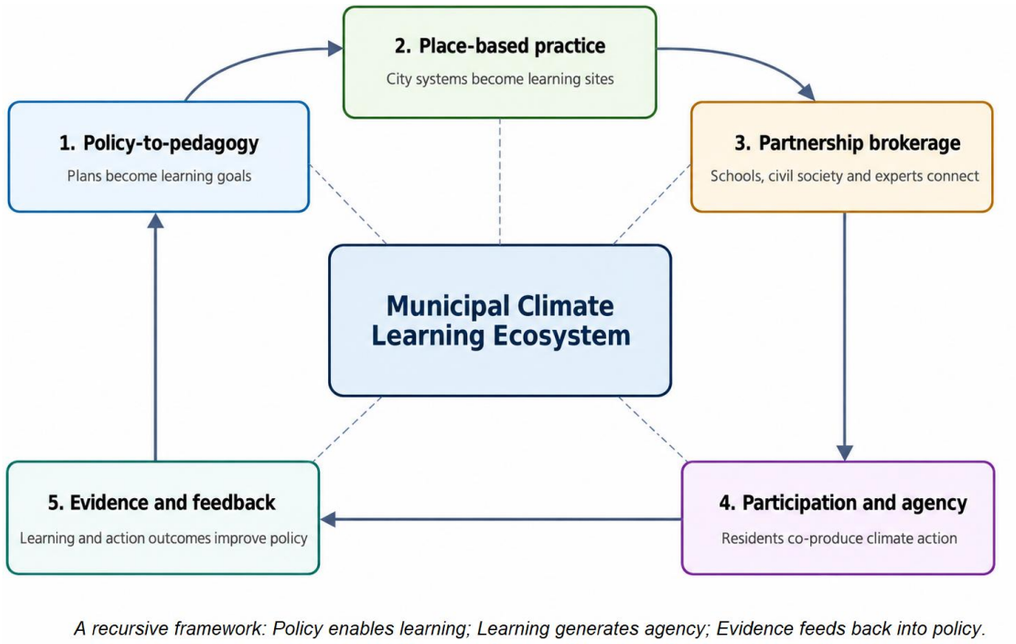


Figure 1. Municipal climate learning ecosystem framework (MCLEF).

Note: **Solid arrows:** Directional links among the five dimensions, forming a recursive cycle in which evidence and feedback inform policy.
Dashed lines: Non-directional conceptual links showing that each dimension forms part of the overarching municipal climate learning ecosystem.

Table 2. MCLEF dimensions and illustrative indicators.

Dimension	Core municipal function	Illustrative indicators
Policy-to-pedagogy	Translate climate priorities into learning objectives for specific groups	Learning objectives embedded in climate actions; unit and audience coverage
Place-based practice	Use municipal systems and public space as living laboratories	Number and accessibility of learning sites; applied inquiry and follow-up
Partnership brokerage	Coordinate schools, universities, civil society, professionals and municipal units	Partner diversity; continuity; shared standards and responsibilities
Participation and agency	Enable residents to deliberate, propose, test and influence action	Response rate to proposals; pilots; perceived efficacy; inclusion
Evidence and feedback	Measure learning and action, and use findings to improve policy	Knowledge, systems thinking, agency, practice and institutional-response measures

MCLEF departs from a conventional environmental-awareness model in three ways. It starts from local climate policy and the public systems through which that policy is implemented, rather than from generic messages. It regards residents as possible co-producers of climate action, not simply as audiences. It also treats institutional response as part of the educational outcome: inviting participation without learning from it leaves the cycle incomplete. Municipalities may use the framework as a diagnostic tool while preparing climate plans, as a guide for implementation across departments and partners, or as a structure for evaluating learning-city activities.

6. Discussion

6.1. Theoretical Contribution

This study brings climate change education, learning-city research, and urban climate governance into the same analytical frame by locating learning in the relationships among municipal policy, public infrastructure, and civic participation. Climate education scholarship identifies features of meaningful learning, including relevance, participation, systems thinking, emotion, hope, and action competence [6-9, 12, 13]. Learning-city research shows how opportunities can be distributed across institutions and throughout the life course [14-16]. Urban climate governance research explains why networks, organizational learning, and institutionalization are needed if local experiments are to have effects beyond individual projects [3-5]. MCLEF connects these insights within a municipal unit of analysis.

Viewed in this way, municipal education is not an awareness campaign added after a technical plan has been completed. The plan itself can be read as a public curriculum because it identifies what the city must understand, debate, and change. Infrastructure is both an object of policy and a possible learning environment. Participation can develop civic competence while producing knowledge that municipal institutions need. Monitoring, in turn, can support collective reflection as well as accountability. The municipality's educational role therefore lies in how governance is designed, not simply in whether a training unit exists.

The ecosystem perspective also guards against project fragmentation. Municipalities often have numerous climate-related activities distributed across departments. Counting them can create the appearance of breadth while concealing disconnected audiences, messages, and outcomes. MCLEF asks a different question: whether people can move through connected opportunities from understanding to practice and influence, and whether the institution can learn from that movement.

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6.2. Implications for Ankara

Ankara's membership in the GNLC offers a practical opportunity to make these connections more durable. Many of the necessary assets are already in place; the key task is to integrate them. A joint climate-learning programme could bring together the Department of Climate Change and Zero Waste, along with the departments responsible for education, youth, culture, social services, parks, transport, water, and communications. Existing activities could then be mapped against climate-plan actions and the five MCLEF dimensions, revealing gaps across age groups, districts, and levels of vulnerability. The same process could establish a limited set of outcomes shared across departments.

Second, Ankara could develop a municipal climate-learning pathway organized around real city systems. Modules on water, energy, mobility, waste, food, biodiversity, heat and disaster resilience could combine open local data, visits to municipal sites, practitioner encounters and community projects. Different versions could serve teachers, children, youth councils, neighbourhood groups, municipal personnel and professional audiences. A common design would preserve coherence while allowing partners to adapt the pedagogy.

Third, participation platforms should be connected to implementation cycles. The Children's Assembly and Youth Assembly already generate environment-related proposals [23, 24]. Annual climate assemblies or thematic labs could use accessible extracts from climate plans and monitoring reports, invite proposals, and publish departmental responses. Selected ideas could become small pilots co-designed with participants. This would demonstrate that climate learning can influence the city while also exposing participants to constraints, trade-offs and evaluation.

Fourth, evaluation should move beyond attendance. A compact city-wide dashboard could report reach and equity, changes in understanding of local systems, action competence, continuity of practice, proposal-response pathways, and institutional changes attributed to engagement. Evaluation findings should be discussed with educators and participants, not only stored as performance data. This would complete the feedback dimension of MCLEF and support GNLC peer learning.

6.3. Transferability, Limitations and Future Research

The framework is intended to be transferable as a set of functions, not as a fixed programme. Municipalities differ in legal authority, financial capacity, educational governance, climate risk, and civic infrastructure. A city that does not administer schools may still convene partners, open public sites for learning, and connect youth participation to planning. Smaller municipalities may work through libraries, community organizations, or regional networks rather than dedicated academies. MCLEF is meant to help each city identify institutions that can perform comparable functions in its own context.

This document-based design also sets clear limits on the findings. Public records reveal formal intentions and reported activities, but they do not capture participants' experiences, informal coordination, programme quality, or causal effects. Municipal communication may emphasize successful activities while giving less attention to discontinuity. In addition, the analysis concerns one metropolitan case at an early stage of GNLC membership. Future studies should combine documents with interviews, observations, and participant-generated evidence; examine differences among districts and social groups; and compare cities with different governance arrangements. Longitudinal research is especially important. A climate learning ecosystem should be judged by whether it builds durable relationships and institutional routines, not only by immediate learning gains. Studies could follow how teacher networks use municipal resources, how youth proposals travel through decision systems, how living-laboratory experiences affect collective action, and how municipal departments revise policy after engagement. Comparative applications could also refine the indicators and identify minimum conditions for ecosystem maturity.

7. Conclusion and Future Scope

Municipalities teach through the choices they make, the systems they operate, the information they disclose, and the opportunities they provide for residents to participate. This educational role does not require local governments to take the place of schools or universities. It requires them to connect climate policy with learning opportunities already present in public services and civic life. Ankara demonstrates both the potential of this approach and the work that remains. Its climate plans, lifelong-learning infrastructure, partnerships, participation bodies, and international learning-city membership provide a strong foundation, but the links among educational objectives, implementation, and evaluation remain incomplete.

The Municipal Climate Learning Ecosystem Framework organizes these links around five dimensions: policy-to-pedagogy translation, place-based practice, partnership brokerage, participation and agency, and evidence and feedback. Together, they reposition climate education from a series of awareness activities to an ongoing civic and institutional learning process. The next step is to test MCLEF with municipal practitioners, educators, and residents, refine indicators that attend to equity and collective agency, and examine its use across different cities. At a time when climate action must become faster, fairer, and more participatory, a city's capacity to learn with its residents may be as important as its capacity to build infrastructure.

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