

Gaia women* garden: Co-Creating a space for transformative learning on bio-/diversity

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Abstract. This paper explores how biodiversity-related learning emerged in the GAIA Gartenberg women's garden in Graz, Austria. Drawing on Science and Technology Studies (STS), we analyse the garden as a socio-material learning environment in which knowledge, agency, and ecological relations are co-produced. Using reflection protocols, field notes, interviews, and Systematisation of Experience workshops, we explore how participation unfolded throughout the gardening season in 2024. The findings show that participation became possible for women in precarious life situations because enabling infrastructures such as land access, childcare, and translation were in place. Relational practices within the group fostered a cohesive and supportive community. Situated learning emerged through embodied, biographically rooted and culturally grounded engagements with plants, soil, insects, and food. More-than-human care practices reshaped participants' ecological sensibilities, and over time, processes of self-organisation, empowerment, and civic agency developed. The study states that transformative learning arises from socio-material and multispecies relations, and community gardens may be considered situated infrastructures of care and co-production that enable inclusive transformative learning.

Introduction

In recent years, growing attention has been put on educational initiatives that aim at addressing ecological crises, including climate change and biodiversity loss. These initiatives often seek to promote behavioural change by encouraging more sustainable lifestyles and consumption patterns. However, despite increased awareness and concern, a persistent discrepancy remains between individuals' values and their actual behaviours. This phenomenon is referred to as the knowing–doing gap, or the attitude–behaviour/value–action gap, which has been extensively explored in environmental psychology (Festinger, 1957; Bentler et al., 2023). STS and feminist scholars have long shown that such knowing–doing gaps cannot be understood solely as cognitive failures but must be analysed through the socio-material and affective conditions that shape

possibilities for action (Haraway, 1988; Suchman, 2007; Latour, 2004). These perspectives highlight how knowledge, agency, and behaviour emerge through relations among bodies, infrastructures, tools, institutional arrangements, and more-than-human actors. From an STS perspective, the focus shifts from individual deficits to the relational, material, and political conditions that enable or obstruct engagement with ecological issues. This includes structural inequalities, institutional path dependencies, and symbolic orders that shape who is able to participate in sustainability initiatives, on what terms, and with which forms of knowledge matter (Jasanoff, 2004). It also includes multispecies relations, e.g. with plants, insects, soil, that shape learning environments and practices (Puig de la Bellacasa, 2017; van Dooren et al., 2016; Houston et al., 2018).

Against this backdrop, this article investigates the Bio-/Diverse Edible City Graz case study within the Horizon Europe research project PLANET4B1. The study employed a participatory action research methodology and initiated learning communities at two interconnected scales: At the meso-level, a policy learning community was formed involving stakeholders from municipal administration, education, environmental sectors, social work, and the arts. At the micro-level, which represents the focus of this article, a community garden ('GAIA Gartenberg') was co-created by and for women* from diverse backgrounds, many of whom experience intersecting forms of marginalisation. Our analysis focuses on how biodiversity-related learning becomes possible when rooted in everyday, embodied practices; how socio-material environments co-produce agency, belonging, and ecological attentiveness; and how community gardening can generate forms of response-ability (Haraway, 2016) that expand participants' sense of what they can know and do.

Inequalities in Access to (Edible) Urban Green Space

Unequal access to urban green spaces reflects not just differences in physical availability but also structural inequities embedded in planning processes, socio-economic constraints, and symbolic orders of belonging (Anguelovski, 2013; Rigolon, 2016). Such inequalities are co-produced by infrastructures, governance arrangements, and cultural norms that privilege particular forms of participation and ecological knowledge (Jasanoff, 2004; Wynne, 1996).

Women, migrants, and residents with limited financial or linguistic resources often face barriers not only to accessing green spaces but also to feeling authorised to shape them (Kaijser & Kronsell, 2014). These dynamics are crucial for biodiversity learning: they influence whose experiences are recognised, which practices count as legitimate, and whose environmental relations inform urban transitions.

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The Bio-/Diverse Edible City: An anchor for just transitions?

While visions of Edible Cities often emphasise self-sufficiency, greening, and health, they may obscure the social, political, and material dynamics that shape who benefits from these interventions (Säumel et al., 2019). From an STS perspective, such visions operate as socio-material imaginaries that mobilise particular urban futures and delineate who is expected to carry the responsibilities for care, maintenance, and ecological stewardship.

We expand the Edible City framework by foregrounding the 'bio' (biodiversity) and 'diverse' (inclusion, plurality) dimensions. This aligns with feminist and decolonial STS perspectives in which ecological practices are understood as situated, relational, and shaped by everyday forms of care (Puig de la Bellacasa, 2017). In this framing, the edible city becomes not a technical intervention but a socio-material and multispecies learning assemblage in which justice, knowledge, and care are negotiated.

Transformative Learning

Transformative learning (TL) has emerged as a critical pedagogical approach (Mezirow, 1990; 2000), yet its predominantly cognitive orientation may be enriched by STS perspectives that foreground how transformations are produced through situated, embodied, and materially mediated encounters. This is what Haraway (1988) calls situated knowledges, which emerge from specific positions, practices, and relations rather than abstract cognition alone. Her concept of situated knowledge shows how learning is grounded in partial, embodied experience—reflected in participants' sensory, cultural, and emotional engagements with plants, insects, and soil.

Jasanoff's (2004) co-production framework illuminates how learning processes intertwine with infrastructures, governance, and material arrangements.

Puig de la Bellacasa's (2017) work on care adds further analytic depth, framing learning as the unfolding of ethical and material entanglements with both human and more-than-human actors. Care here is not an add-on but a condition that enables knowledge, relations, and ecological attachments to grow (see also Houston et al., 2018). These perspectives reposition TL as a relational, socio-material process in which cognitive shifts are inseparable from changes in practice, sensibility, and response-ability (Haraway, 2016)

Community gardens as socio-material learning environments

Community gardens have increasingly been recognised as fertile ground for transformative learning that engages individuals not only cognitively, but also emotionally, socially, and ethically. These spaces foster forms of experiential learning that connect people to local ecologies, food systems, and community relationships, often catalysing shifts in perception, values, and behaviour (Mezirow, 2000). Community

gardens have been theorised as socio-material learning spaces where knowledge emerges through embodied activity, multispecies encounters, and collective experimentation (Pudup, 2008; Guitart et al., 2012). From an STS perspective, community gardens can be understood as socio-material *assemblages* (Deleuze & Guattari, 1987 in Müller, 2015) in which humans, tools, plants, insects, soils, and infrastructural arrangements co-constitute the conditions of possibility for action, collaboration, and learning. In these assemblages, knowledge and agency emerge not from individual actors alone but from the dynamic interactions among material arrangements, more-than-human organisms, and social relations.

This aligns with scholarship showing how civic and grassroots initiatives enact alternative environmental futures (Ghose & Pettygrove, 2014). In such settings, hands-on practices, shared labour, and collective decision-making enable participants to develop critical awareness of social and environmental injustices while simultaneously building practical skills and ecological literacy (Aiken, 2016; Egerer et al., 2019). Community gardens thus act as transformative learning environments where knowledge is co-created through embodied interaction with the land and other community members (Sipos et al., 2008). Consistent with this, the GAIA Gartenberg garden became a place where biodiversity was learned through touch, care, sensory experience, and multispecies entanglements.

Positioning community gardens in this way supports our analysis of the GAIA Gartenberg case as a socio-material and multispecies learning environment in which participants developed situated ecological knowledge, emotional attachments, and emerging civic agency.

Methodology

Our case study employed a participatory action research (PAR) design that combined collaborative garden co-creation with regular research interventions and ongoing qualitative evaluation. The methodological approach was informed by TL theory and complemented by STS concepts of co-production and care.

Case Study Description

The citizens' LC was implemented between March and September 2024 in Graz, Austria, as part of the PLANET4B project. The case study centred on the co-creation of the GAIA Gartenberg women's community garden, developed in close collaboration between IFZ researchers, gardeners from Forum Urbanes Gärtnern (FUG), and 10–15 participating women*. Meetings took place weekly on Fridays for 3 hours, regardless of the weather. Most sessions were held on-site, and some were held at a nearby community centre during periods of bad weather.

The garden space was intentionally designed as a women*-only environment, co-facilitated by pedagogically trained female gardeners from FUG, and guided by principles of brave spaces (Arao & Clemens, 2013), accessibility, and care. The weekly meetings combined gardening activities, collective decision-making, reflection exercises, shared meals, and structured research workshops on biodiversity, food systems, and diversity.

We conceptualised the GAIA Gartenberg as a socio-material setting in which knowledge, relations, and forms of agency were co-produced. Following Jasanoff (2004), we understand co-production as the intertwined making of social order, knowledge, and material arrangements. Rather than treating the garden as a neutral backdrop, we approached it as a dynamic assemblage of people, materials, practices, and norms that actively influenced the learning process.

To support learning processes and generate empirical material, a series of structured research interventions was embedded into the gardening process. These activities were designed to elicit experiential knowledge, stimulate reflection, and anchor biodiversity-related issues in everyday practice. The first activity was an '*experience-stroll*' through the future garden site. It encouraged participants to articulate prior gardening experiences, expectations, and cultural connections to plants and food. As the garden developed, further interventions included a community-mapping (Taliep & Ismail, 2023) exercise to identify needs, barriers, and opportunities for future use; socio-scientific inquiry workshops (e.g. on apple varieties; Zeidler & Kahn, 2014) to explore biodiversity, seasonality, labour conditions, and food system dynamics. Another workshop on diversity, accessibility, and inclusion was held to connect personal experiences with broader questions of justice.

Co-creative processes were a defining feature of the study design. Participants developed the garden plan together, drawing on their collective knowledge, preferences, and practical considerations. A thematic Milpa or 'Three Sisters' bed (inspired by Kimmerer, 2013) was jointly established, and the garden was collectively named 'GAIA Gartenberg'. These co-creative practices reflected an STS-informed commitment to epistemic pluralism, integrating practical, cultural, sensory, and situated expertise alongside scientific or technical knowledge (Norström et al., 2020; Klein, 2004; Lang et al., 2012).

All weekly meetings were structured along check-ins, gardening work, shared meals, reflective discussions, and check-outs. As such, they functioned simultaneously as pedagogical tools and as integral components of the research design, enabling the production of rich qualitative insights into learning, collaboration, and the socio-material dynamics shaping participants' engagement with biodiversity.

Data Sources

Our research relied on four qualitative data sources:

(a) *Reflection protocols*: After each Friday session, open-ended reflection protocols were completed by the FUG facilitation team. These protocols captured general observations, group dynamics, critical incidents, and emerging learning moments. They were not based on structured templates but followed a qualitative memo style that allowed for the flexible capturing of emerging issues.

(b) *Researcher field notes*: IFZ researchers maintained open, descriptive field notes, documenting interactions, decision-making processes, material challenges, and emotional or relational dynamics. Notes were recorded during or immediately after sessions.

(c) *Individual follow-up interviews*: Seven individual ex-post interviews were conducted with women* in early spring 2025, each lasting approximately 60 minutes. The interviews followed a semi-structured guide and focused on participants' reflections on learning processes, experiences of co-creation, encounters with biodiversity, perceptions of agency and belonging, and expectations for the future development of the garden. Participation was voluntary, and the sample size reflects availability and willingness rather than a strategic sampling.

(d) *Systematisation of Experiences (SoE)*: At the end of the gardening season, four SoE workshops (Herout & Schmid, 2015) were conducted with the women*, the research team and members of the policy LC. This collective reflection exercise generated structured insights into how participants interpreted key moments, challenges, and turning points in the co-creation of the garden. The SoE workshops produced a collaboratively developed narrative of the group's learning journey, which served both as data and as a validation tool for preliminary interpretations.

Together, these four data sources provided complementary insights into how learning processes were co-produced through social, material, and affective engagements throughout the gardening season.

Data analysis

We analysed the four data sources outlined previously and followed an iterative, interpretive, and STS-informed approach. Rather than coding for predefined categories, we traced how meanings, practices, and relationships emerged across the season.

Analytically, we moved iteratively across these materials, guided by feminist and STS concepts of situated knowledge (Haraway, 1988), care (Puig de la Bellacasa, 2017) and *response-ability* (Haraway, 2017), and co-production (Jasanoff, 2004). We focused on: embodied and affective learning, the negotiation of interpersonal relations, socio-material

entanglements with plants, insects, tools, and infrastructures, and the emergence of care, agency, and collective responsibility.

Results

The empirical findings illustrate five interconnected dynamics: (1) how material, institutional, and social infrastructures enabled participation; (2) how a diverse group of women* gradually became a cohesive community through shared practices and mutual trust; (3) how experiential and culturally situated learning unfolded through workshops, everyday gardening, and creative methods; (4) how participants developed new forms of more-than-human attentiveness and care through encounters with plants, insects, soil organisms, and ecological processes; and (5) how self-organisation, confidence, and civic agency emerged as participants began to imagine and enact future responsibilities for the garden.

Enabling Conditions as Co-Produced Infrastructures

Before establishing the *citizens LC* of the *Bio-/Diverse Edible City Graz*, we began with a careful exploration of the setting – including the social context, spatial characteristics, and related factors and participants' needs.

To ensure low-threshold participation in the citizens LC, we needed to establish enabling conditions. Structural and emotional barriers, such as language, previous negative experiences with institutions, or unfamiliarity with environmental topics, were explicitly acknowledged and addressed through multilingual facilitation (German, English; and using Google Translate to Russian and Ukrainian), informal settings, and an appreciative approach to existing knowledge and practices.

Based on our reflections within the SoE we identified key resources at multiple levels:

(1) *Physical resources* included a dedicated garden plot (slightly remote, but easily accessible and big) provided by the city administration, access to essential infrastructure such as water, soil, compost, and tools, as well as storage space for materials, which were fundamental to ensuring that gardening and learning could take place consistently and safely.

(2) *Financial support* through the PLANET4B research project provided funding not only for material needs but also for process facilitation, childcare, translation support, and other activities that enhanced accessibility and continuity.

(3) *Personal and social resources* were essential for both understanding the local context and reaching out to potential participants. Local actors, such as community workers, neighbourhood organisations, and practitioners in community-based work, played a key role in identifying whom to approach, how, and where. They also served as trusted points

of contact within the community, owing to their established networks and trust-based relationships. These connections were crucial for engaging women* from diverse and often marginalised backgrounds and for lowering initial barriers to participation. As one participant expressed, *'I really felt received as if I belonged here [...] I was welcomed warmly and openly.'* (EPI_W1_20022025)

(4) *Symbolic and institutional resources* included the absence of resistance from surrounding residents and the general goodwill of municipal actors, including those responsible for green space and urban development. An explicit political endorsement to foster urban social gardening, and the fact that the project encountered only little administrative or social obstruction, were themselves significant enabling conditions. In this sense, symbolic space - the room to experiment, fail, and grow without being overly scrutinised or instrumentalised - was just as important as physical space. All this allowed the project to maintain low-threshold participation while responding flexibly to participants' needs.

These enabling conditions allowed facilitators and participants to treat the garden as a site for learning rather than performance. In STS terms, these enabling conditions illustrate how material, institutional, and social arrangements co-produce the very possibility of inclusive participation.

Becoming a community: group formation, trust, identity

Considerable attention was given to creating relational safety, group-building and visioning. Thus, early engagement formats were intentionally designed as 'brave space' (Arao & Clemens, 2013), allowing participants to engage emotionally, share vulnerabilities, and navigate linguistic and cultural differences without fear. One woman captured this sense of grounding: *'Being welcomed, having a quiet moment at the start [...] it helped me to slow down from everyday life.'* (EPI_4_25022025)

Routines and rituals, such as check-ins and check-outs, meals, and sharing personal stories and memories, helped to establish continuity and familiarity. As another participant recalled: *'We always had a check-in and a check-out [...] it gave rhythm and helped us feel connected.'* (EPI_W5_11032025) These relational practices reflect Haraway's (1988) concept of situated knowledge: learning begins by locating oneself among others, within shared practices and affective ties.

A formative moment in community building occurred when the women* collectively decided to build the garden fence themselves. Initially, some suggested asking male relatives for help, yet the group chose to take the task into their own hands. The embodied experience of constructing the fence by driving posts into the earth, stretching wire, clearing stones etc. became a symbolic act of empowerment and claiming the space. Within the SoE this was highlighted a critical moment for several times, and its significance was emphasised in the interviews as well: *'Being able to hammer a fence*

post into the ground as a woman [...] it was something I never imagined I could do.' (EPI_W4_25022025) Another woman remembered: *'We collected stones like ancient humans and stretched the fence [...] and we women really managed it well.'* (EPI_W6_13032025)

This exemplifies infrastructuring as a co-productive process (Star & Bowker, 2006): material arrangements (the fence) and social relations (confidence, trust, collective ownership) emerged together. As one participant summarised the developing community ethos: *'Through the working together, trust came naturally. You don't need the same language when your hands are doing the same task.'* (EPI_W6_13032025)

By the end of the season, a strong sense of collective identity had formed. Reflection notes from the second community mapping at the end of the harvesting season show how the garden became a place of belonging: *'When I think of the garden year, my body feels warm [...] the place has become familiar.'* (CM2_follow-up reflections_25102024) This affective attachment resonates with Puig de la Bellacasa's (2017) understanding of care as an ongoing cultivation of relations, not only among humans but also toward place and the more-than-human, and with gratitude for the gifts the garden offered.

Situated learning practices: experience walks, workshops, mappings

As trust solidified, learning processes became increasingly situated, experiential, and co-created. Rather than introducing biodiversity and social diversity as abstract topics, facilitators grounded them in sensory experience, embodied practices, and participants' lived histories. This approach reflects Haraway's argument that knowledge emerges from partial perspectives located in experience.

Activities such as a *'nature experience stroll'* served as relational entry points into the topic of biodiversity, encouraging participants to share personal memories related to plants, food, and places from their own lives. These moments were not framed as didactic tools, but as openings for meaning-making rooted in lived experience. Reflection notes describe how *'the format enabled a form of learning through place: knowledge was not transmitted abstractly but anchored bodily, sensually and socially'* (NES_reflection notes_22032024). Women* articulated connections between biodiversity and their own biographies: *'For me a garden means connecting and communicating with the earth and the plants. and seeing what grows from my hands'* (NES_reflection notes_22032024).

In the socio-scientific issues (SSI) workshop on apples, participants evaluated varieties based on taste, economic aspects, ecological issues, and cultural resonance. As reflection notes highlight: *'The diversity of apples surprised me; each taste led to a different discussion'* (SSI_WS1_reflection notes_26072024). Another participant summarised: *'Every workshop fed my mind; I learned so much from the others.'* (EPI_W3_Datum) This illustrates how ecological knowledge emerged through collective reasoning situated within everyday constraints and values.

Learning also unfolded through weekly routines. As one participant explained: *'We always did a check-in and a check-out [...] during the break everyone brought something to eat; we talked about what we had cooked from last week's harvest and shared recipes in the WhatsApp group.'* (EPI_W5_11032024) Through such practices, knowledge was co-produced through communicating, doing, tasting, sharing, and reflecting together.

The diversity workshop further illustrated situated learning by making linguistic and cultural plurality visible: *'Hearing the word 'garden' spoken in twenty languages created a moment of pride and curiosity.'* (DWS_reflection notes_06092024) Here, difference became an epistemic resource rather than a barrier, aligning with feminist STS approaches that value plurality and relationality (Haraway 1988).

More-than-human and care practices

A central aspect of learning in the GAIA garden was the cultivation of more-than-human relations. Through touching, observing, and regular interaction, participants related to plants, insects, soil organisms, and seasonal rhythms. Haraway's notion of response-ability (2016) offers a useful conceptual lens here: learning involved becoming capable of responding to the needs and signals of non-human others.

Participants articulated this shift explicitly. One woman described learning new forms of attentiveness: *'Learning how much water each plant needs made me feel responsible for them [...] like they depend on us.'* (EPI_W6_13032025) Another emphasised temporal ethics: *'The garden taught me patience. You cannot rush a plant. You have to care for it and wait.'* (EPI_W3_20032025)

Observations of insects also changed: *'When the flower meadow behind the garden emerged, it changed a lot visually and surely attracted many more insects.'* (EPI_W5_11032025) A particularly illustrative example of transformed relations to nature comes from a participant who spoke about overcoming her long-standing fear of insects. She explained that before joining the project, she could not sit on grass because she was afraid something might crawl onto her and would 'jump' whenever she encountered insects. Through repeated encounters in the garden and reassurance from others, this fear gradually diminished: *'This fear has been gone [...] now I'm like, okay, it's okay.'* She also noted how observing other women calmly brushing insects away, and seeing children move freely and unafraid in the garden, helped her reframe these interactions: *'Looking at that, I thought it's not that big a deal to be in nature.'* (EPI_W7_11032025).

An even more complex example of ethical and emotional engagement with the more-than-human emerged in relation to the garden's recurring snail infestation. One participant described how she absolutely refused to kill snails, expressing strong discomfort and moral resistance: she carried hundreds of them by hand 'far up into the forest' rather than harming them. She explained that she could not kill a living being without certainty that it would suffer 'not even a second,' and that contradictory advice

from others only deepened her unease. She noted that *'everyone was somehow avoiding the topic, everyone was unsure'* (EPI_W6_13032025), illustrating how the group collectively navigated the ethical ambiguity of multispecies encounters. This narrative captures how care, uncertainty, and ethical negotiation shaped participants' relations with more-than-human life, revealing the garden as a site where moral and practical worlds are co-produced.

Such insights show how the garden functioned as a multispecies contact zone, a space where ecological processes became perceptible through embodied engagement. What was once experienced as a threat became normalised through collective practice and shared presence, which illustrates how response-ability emerges not through instruction but through situated, relational exposure.

Care practices extended beyond plant cultivation into cooking and food preparation. Participants exchanged recipes, experimented with unfamiliar vegetables, and developed confidence in using produce from the garden. As one woman shared: *'I always saw kohlrabi on the counter but never knew how to make it [...] then people cooked it at home and brought it, and when I tasted it I thought: oh, this is nice. Now I know how to make it.'* (EPI_W7_22032025)

In Puig de la Bellacasa's terms (2017), these examples illustrate how care is simultaneously affective, material, and epistemic; it is a mode of engagement that binds people, plants, insects, soil, spaces, and shared meanings together.

Emergent agency, self-organisation and the future-making

By mid-summer, participants increasingly articulated long-term visions for the garden and demonstrated growing confidence in collectively managing it. This transition from facilitated engagement to autonomous self-organisation marks a key outcome of the co-productive learning process.

In the community mapping follow-up, women* expressed diverse yet converging future imaginaries. One noted: *'Now I can imagine the garden in a new year, who is there, what I will do, what grows [...] it has become part of my life.'* (CM2_follow-up reflections_25102024) Another reflected: *'Now I know I can grow vegetables at home, Mangold, tomatoes [...] it comes fast, and I feel confident.'* (EPI_W7_11032025)

Discussions about founding a nonprofit association, which is a requirement for long-term stewardship of community gardens in Austria, further revealed emerging civic agency. As one participant stated: *'I want to be a role model [...] to do my part so the next generation can also harvest.'* (EPI_W5_11032025) Another summarised the group's growing autonomy at the end of the growing season: *'We no longer need someone to tell us what to do in the garden, we already know how to organise ourselves and decide together what needs to happen.'* (CM2_follow-up reflections_25102024)

Participants also emphasised the emotional significance of the women-only space: *'The women's space is special. Here I discovered abilities I never believed I had.'* (CM2_follow-up reflections_25102024) Another described the garden as a personal refuge: *'This is my happy place. A space to feel free and share experiences.'* (CM2_follow-up reflections_25102024) These statements illustrate how empowerment, identity, and belonging were co-produced through socio-material and relational practices.

Finally, women* articulated increased confidence in broader social settings: *'I am no longer afraid to join new groups; I know now that people will treat me kindly.'* (EPI_W6_13032025) This shift signals how the GAIA garden functioned as a site of civic learning, enabling women* to imagine themselves as active contributors to urban ecological futures.

Taken together, these findings show how agency, responsibility, and future-making were co-produced through the intertwined dynamics of everyday practice, shared decision-making, and care for the space.

Discussion

The case study shows how the citizen LC operated as a situated experiment in co-producing infrastructures, knowledges, and subjectivities, rather than as a neutral educational intervention. Bringing Jasanoff's (2004) notion of co-production together with the work of Haraway (1988, 2016) and Puig de la Bellacasa (2017) enables us to understand the GAIA Gartenberg case as an example of how social relations, material arrangements, and ways of knowing were created and reshaped together.

First, the results demonstrate that enabling conditions were not pre-given but actively *infrastructured* (Star & Bowker, 2006) through the joint work of the PLANET4B project team and the women themselves, with support from municipal actors. Access to land, water, tools, storage, childcare, translation, and process facilitation provided a socio-material basis for women* in precarious life situations to participate. Participants' descriptions of feeling 'received' and 'welcomed warmly and openly' indicate that infrastructuring was simultaneously material and affective. This resonates with co-production in Jasanoff's sense: institutional commitments to urban gardening, funding streams, and garden infrastructures did not simply support an already-existing learning process. These aspects co-defined who could become a participant, which forms of knowledge were legitimate, and what futures could be imagined.

Second, the findings specify how situated knowledge (Haraway, 1988) was generated through embodied and culturally inflected practices. Activities such as the nature experience walk, the socio-scientific issues workshops, and community mappings anchored biodiversity in everyday experiences of taste, memory, and place. When women linked gardens to childhood memories, migration histories, or family recipes, they

enacted what Haraway calls *partial perspectives*: knowledges that are local, accountable, and entangled with biography rather than abstract universal truths. The multilingual setting and the ongoing translation support from facilitators and peers show that knowledge was not simply passed on but carefully built together across different languages, cultures, and experiences. In this sense, the GAIA garden became a site where epistemic authority was redistributed and where gardening expertise, sensory impressions, and everyday food practices were treated as legitimate contributions alongside scientific or policy-oriented perspectives.

Third, the project shows how practices of care were central to learning, aligning with Puig de la Bellacasa's (2017) understanding of care as affective, material, and epistemic at once. Care appeared in everyday activities, like watering plants, collectively managing the 'snail problem,' experimenting with new vegetables, cooking and sharing food, or gently supporting women who were initially anxious about insects or social exposure. These practices did more than maintain the garden: they produced attachments, responsibilities, and forms of attentiveness. The woman who carefully carried snails 'far into the forest' rather than killing them, and who later reflected on her uncertainty about how to avoid causing suffering, exemplifies how ethical and ecological questions became folded into everyday routines. Likewise, the participant who overcame her long-standing fear of insects by watching others brush them off calmly, and by observing how children moved unafraid through the garden, illustrates how *response-ability* (Haraway, 2016) is cultivated through repeated multispecies encounters rather than through moral injunctions alone.

Fourth, the study contributes to debates on transformative learning by showing how transformation unfolded as a socio-material, more-than-human process rather than as a purely cognitive shift. Across the season, women reported increased confidence in gardening, food preparation (e.g. fermenting vegetables and cooking with previously unfamiliar varieties), and joining new social groups. These changes were tethered to concrete practices: building the fence, co-designing the garden layout, reflecting on the value of varieties, or co-founding the association. The transition from relying on facilitation to articulating that they would not need someone to tell them what to do in the garden signals a shift in agency that is inseparable from the shared work of maintaining beds, negotiating responsibilities, and imagining future uses of the site. Rather than a sudden *disorienting dilemma* (Mezirow, 2000), transformation in this context unfolded gradually, as participants' sense of what they could do shifted through their ongoing engagement with tools, soils, plants, institutional actors, and one another.

Fifth, the case foregrounds the gendered and intersectional dimensions of co-production. The women-only setting functioned as a protected, *brave space* in Arao and Clemens' (2013) sense, where participants could experiment with new roles and practices without fear of ridicule or surveillance. Many women described discovering abilities 'I never believed I had' and naming the garden as a 'happy place' and refuge. For women affected

by migration, low income, care burdens and language barriers, the combination of spatial seclusion, female facilitation, and low-threshold entry points (food, children welcome, no prior expertise required) was crucial. From an intersectional STS perspective (Cranshaw, 1989), this highlights that inclusive edible city initiatives must address not only physical access but also symbolic safety, gendered power relations, and the time–care regimes that structure who can participate and when.

Finally, the discussion must also address tensions and limits. The project depended heavily on external funding, committed facilitators, and an unusually supportive municipal context. Infrastructuring, in this sense, is both enabling and fragile: if funding streams or political priorities shift, the carefully co-produced conditions for participation may erode. Moreover, while the case aimed to redistribute agency, it also relied on unpaid volunteer labour and emotional work by facilitators and participants—raising questions echoing critiques of neoliberal *responsibilisation* in community-based sustainability initiatives (Mayer, 2012; Rosol, 2017). The more-than-human dimension, though present, remained somewhat bounded by the immediate concerns of food, pests, and plant care; broader biodiversity politics, species loss, or contested land-use regimes could only be touched upon. These limitations underline that GAIA Gartenberg should not be read as a fully realised alternative but as a situated, partial experiment that opens particular possibilities while leaving other structural dynamics intact.

Taken together, the Bio-/Diverse Edible City Graz case shows that when co-production, situated knowledge, and care are taken seriously, community gardens can become laboratories for reconfiguring socio-ecological relations. The garden did not solve systemic inequalities, but it made them negotiable in new ways, allowing women to inhabit roles as gardeners, association founders, neighbours, and carers of plants and insects that previously seemed closed or risky. In doing so, the case adds empirical texture to STS debates about how small-scale, everyday practices can participate in the making of more just and liveable urban futures.

Conclusions

This article has examined how transformative learning about biodiversity and urban nature emerged in the GAIA Gartenberg women's garden as part of the Bio-/Diverse Edible City Graz case. By bringing feminist and multispecies STS concepts into dialogue with transformative learning theory, we argued that learning in this context was co-produced through specific socio-material arrangements and care practices rather than through information transfer alone. The study's key contributions lie in three interrelated insights:

First, the case demonstrates that enabling participation for women in precarious life situations requires more than 'inviting' them into pre-existing initiatives. It demands

deliberate infrastructuring: securing land and basic infrastructure; providing translation, childcare, and respectful facilitation; and cultivating institutional goodwill that protects the project from bureaucratic friction. These infrastructures are not mere background conditions but active components of co-production, shaping whose knowledge counts and whose futures are thinkable in the edible city.

Second, the findings demonstrate how biodiversity-related learning becomes meaningful when it is anchored in situated knowledges and more-than-human relations. Experience walks, apple-tasting workshops, community mapping, and everyday encounters with plants and insects allowed women to weave ecological concerns into their own biographies, emotions, and routines. Through these entangled practices, response-ability and care extended from the human community to soil organisms, insects, and cultivated plants, illustrating Puig de la Bellacasa's (2017) claim that caring is simultaneously about maintaining worlds and learning to know with others.

Third, the GAIA Gartenberg case illuminates how community gardens can function as small but significant sites of future-making. The emergence of self-organisation, the founding of an association, and the articulation of long-term visions for the area demonstrate how participants began to see themselves as legitimate actors in urban socio-ecological transformations. The garden became an anchor for broader developments—such as planned orchard meadows and a community park—while also feeding back into policy discussions through the policy LC. In this way, the case renders visible how modest, local initiatives can ripple into wider governance arenas when supported by attentive facilitation and receptive institutions.

At the same time, we emphasise that these outcomes are context-specific and non-transferable in a simple sense. Replication elsewhere would require not only similar funding and municipal support but also careful attention to local histories, power relations, and more-than-human ecologies. Rather than offering a template, the Bio-/Diverse Edible City Graz case provides a situated example that can inspire other actors to ask: what infrastructures of care, what forms of co-production, and whose situated knowledges would be needed to enable comparable processes here?

For researchers and practitioners working at the intersection of STS, urban governance, and sustainability education, the case suggests that designing transformative learning environments means designing socio-material worlds: assembling infrastructures, relations, and practices that allow marginalised groups to experiment with new ways of knowing and acting. Future work could deepen this perspective by tracing longitudinally how such initiatives endure or transform once project support ends, and by engaging more explicitly with conflicts and frictions over land use, labour, or species priorities that inevitably accompany attempts to reconfigure urban socio-ecologies.

In sum, the Bio-/Diverse Edible City Graz case underscores that transformative learning in community gardens is not a method to be applied but an emergent process. It emerges

where shared infrastructures, situated knowledges and practices of care come together, creating conditions that allow different urban futures to be imagined and tried out, even if only temporarily.

Methodological Limitations

While the analysis highlights more-than-human relations, our empirical access to multispecies interactions was inevitably partial and mediated through human accounts, observations, and research interventions. This means that the more-than-human perspective remained largely inferred rather than systematically documented, reflecting a common challenge in ethnographic and participatory STS research. The focus, by design, remained on making biodiversity relevant to the everyday lives, priorities, and cultural frames of the participating women*, which itself can be understood as a necessary first step toward inclusive ecological literacy.

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AI use disclosure

Parts of the writing process were supported by using AI tools. Perplexity.ai and ChatGPT (v4) were employed for literature searches, while ChatGPT also assisted in developing structural ideas for the results chapter and refining language and phrasing, based on author-provided arguments and partial drafts. All final texts were carefully revised and proofread by the authors. The interpretations and final decisions are solely the responsibility of the authors.

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