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Teaching Perceptual Landscape Visualization through Multisensory Studio-Based Learning: An Urban Street Case Study

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ABSTRACT
This study examines multisensory perceptual landscape mapping as a studio-based representational approach in landscape architecture education. Conducted within a fourteen-week undergraduate studio, the study involved six students who explored Kamil Demircioğlu Street in Kastamonu, Türkiye, through repeated sensory walks addressing visual, auditory, olfactory, tactile, and gustatory characteristics. Students used observation sheets, field notes, sketches, and five-point perceptual ratings as intermediate studio tools; however, the research dataset consisted only of the six final student-generated multisensory perceptual landscape maps. The maps were analyzed through systematic qualitative comparison using five a priori sensory categories and a cross-participant analytical matrix to identify recurring and divergent sensory-spatial patterns. A researcher-generated Lynch imageability analysis provided a complementary spatial framework for interpretation. The findings revealed recurring associations between traffic and negative auditory experience, food and beverage functions and olfactory/gustatory experience, and hard-paved versus softer-green surfaces and tactile perception. Visual representations showed greater variation, although openness, extended views, natural scenery, and distinctive spatial elements were frequently represented positively. Individual maps also retained differences in sensory emphasis, spatial interpretation, and graphical expression. The study contributes a studio-based framework that connects embodied multisensory observation, urban spatial structure, graphical representation, and cross-participant qualitative comparison while preserving perceptual diversity rather than reducing individual experiences to a composite map.
Keywords: multisensory perception; perceptual landscape mapping; landscape architecture education; studio-based learning; sensory walks; urban streetscape

INTRODUCTION
With the theories of sensory experience that emerged in the early 20th century, the rapidly changing and transforming urban areas have increasingly been shaped by multi-layered senses as an essential part of everyday life (Degen & Rose, 2012). Initially emphasized in architecture, sensory qualities beyond the visual dimension have also come to the forefront of environmental experience (Schafer, 1977; Lynch, 1960; Lefebvre, 1991; de Certeau, 1984; Debord, 1957/2006; Tuan, 1974, 1977; McLuhan, 1962; Hall, 1968; Zardini, 2005; Howes, 2005; Mattern, 2008).

In this respect, the idea that the visual analysis of cities alone cannot fully represent urban experience has gained importance (Degen, 2008; Adams & Guy, 2007). Consequently, senses such as sound, smell, and kinesthetic perception have been recognized as significant elements of daily practices, while potential physical changes in urban spaces are noted to affect these experiences (Degen & Rose, 2012).

Urban streets constitute the core of these experiences and represent the liveliest parts of public life. The qualities carried by streets influence residents' perceptions, social interactions, and behaviors (Ewing & Handy, 2009). Various studies on street quality have assessed parameters such as building character, vegetation, spatial enclosure, and

pedestrian behavior, often combining them with objective measurements (Naik et al., 2014; Rui et al., 2022; Liu, 2022). With rapidly advancing technologies, digital tools have increasingly been used to evaluate street quality, particularly through large-scale analyses based on street view images (SVI) (Naik et al., 2014; Wei et al., 2021; Ogawa et al., 2022). However, such methods tend to disregard the spirit of place, thereby lacking the subjective judgments of users. Subjective, perception-based approaches, by contrast, incorporate interpretive perspectives (Ewing & Handy, 2009; Wesener, 2024). Among these approaches, walking is a frequently used method that plays an important role in experiencing the city. Since it relies on multi-sensory experience, walking enables a holistic perspective (Adams & Askins, 2009; Degen & Rose, 2012) and has been widely applied in studies on urban environments and urban experience.

In landscape architecture education, the survey phase constitutes one of the first and most important stages of planning and design processes. The perceptual landscape, shaped by natural and cultural reflections, is considered as a fundamental dataset in this context. Mapping such a layer is based on field observation. Therefore, in the learning approaches of landscape architecture students, on-site observations and sensory walks are essential practices for gaining concrete experience. Kolb's (1984) experiential learning model, composed of concrete experience, reflective observation, abstract conceptualization, and active experimentation, provides a strong theoretical basis for contexts where multi-sensory experiences are integrated into educational processes. Recent studies have demonstrated that such environment-based learning activities enhance both environmental awareness and students' empathy and social bonding skills. Particularly, approaches such as Public Participation GIS (PPGIS) and Multi-Sensory PPGIS (MSPPGIS) actively involve participants' senses in mapping processes, enabling the production of both qualitative and quantitative data (Korpilo et al., 2023).

This study investigates the use of multisensory perceptual landscape mapping as a studio-based learning approach in landscape architecture education. Rather than examining the sensory character of Kamil Demircioğlu Street as the primary research object, the street is employed as an authentic urban learning environment in which students observe, interpret, and visually represent multisensory experiences. The study specifically examines how students engage with visual, auditory, olfactory, tactile, and gustatory dimensions during sensory walks, how these observations are transformed into perceptual landscape representations through iterative studio activities, and what recurring or divergent sensory-spatial patterns emerge across the resulting student maps. Accordingly, the study focuses on the educational process and its representational outputs, while the sensory characteristics of the street provide the empirical context through which this process is examined.

THEORETICAL FRAMEWORK

Senses and Urban Perception

Senses, as the fundamental medium of interaction with the environment, embody a holistic multi-sensory character (Rodaway, 2002; Howes, 2005). Understanding and interpreting the elements of urban design that directly influence user perception play a central role in creating more preferred environments. Visual perception, which comes first, evaluates the objective qualities of space (Alexander, 1979; Rapoport & Hawkes, 1970; Schutz, 1972), and visual information is widely acknowledged to have a strong effect on human memory (Surat, 2017; Huang & Lin, 2020). Pallasmaa (2012) and Holl et al. (2006) argue that spatial experience is not limited to sight but rather consists of a holistic process in which all senses operate together. This approach emphasizes that the meaning of space emerges from such interactions and that the multi-sensory perception of urban spaces can best be understood through user-centered methods.

Perceptual Landscape

The significance of visual landscape in urban space was first emphasized in the works of Lynch (1960), Nasar (1998), and Kaplan & Kaplan (1989). Subsequent research assessed

the quality of urban environments through a wide range of characteristics (Daniel & Boster, 1976; Zube et al., 1982; Tveit et al., 2018). Since the 1970s, the concept of soundscape (Schafer, 1977) has developed as a critical field complementing visual analyses. Soundscapes reveal the role of various auditory sources, ranging from traffic noise to natural sounds, in environmental experience (Kang & Schulte-Fortkamp, 2016; Davies et al., 2013). Studies examining the interaction between visual and auditory elements in urban environments indicate that cross-modal effects influence perceptions, such as the impact of visual settings on sound evaluations (Viollon, Lavandier, & Drake, 2002).

The concept of smellscape, introduced by Porteous (1985), adds an invisible yet defining layer to the urban environment by highlighting the role of smell in spatial memory. Although the difficulty of measurement has often relegated smell to the background, Henshaw (2014) underlined its importance in urban planning and design, mapping urban smellscapes at micro-, meso-, and macro-scales through sensory walks. Smells, like visual and auditory elements, form part of the layers of meaning in cities and are regarded as intangible cultural heritage that shapes collective memory (Ayan Çeven & Belkayalı, 2023). By mapping these senses, not only can daily experiences be represented, but visitors can also evaluate cities from multiple perspectives (Brown & Kyttä, 2014).

Walking, frequently employed by sociologists and urban geographers, enables a holistic understanding of the relationship between street and user while emphasizing temporal factors. At the same time, walking highlights the role of tactility in strengthening the relationship with place (Parker et al., 2024). The psychological effects of tactile landscapes are particularly emphasized. Sepe (2013) notes that differences in material textures can significantly alter place perception, arguing that, similar to sound and smell, tactile qualities are strongly associated with the enjoyment of urban space.

Conceptual Framework: Multisensory Studio-Based Learning in Landscape Architectural Education

Landscape architecture education is inherently grounded in studio-based learning, where knowledge is constructed through iterative cycles of observation, interpretation, representation, critique, and reflection. Rather than functioning solely as a physical learning environment, the design studio represents an epistemic space in which students progressively transform experience into disciplinary knowledge through active engagement with real-world contexts. Recent reviews of studio pedagogy emphasize that learning in design disciplines is fundamentally experiential, dialogic, and reflective, distinguishing studio education from traditional lecture-based instruction (Hettithanthri and Hansen, 2022). Within this pedagogical tradition, field observation constitutes one of the fundamental components of landscape architectural education. Nevertheless, conventional site analysis frequently privileges visual observation, while the contribution of auditory, olfactory, tactile, and gustatory experiences remains comparatively underexplored. This visual dominance has increasingly been questioned by scholars advocating embodied and multisensory approaches to design education. Recent studies argue that integrating multiple sensory modalities into studio activities enables students to construct richer cognitive representations of place and improve conceptual thinking during design development (Ebbini, 2026).

The theoretical foundation of the proposed framework draws primarily upon Experiential Learning Theory (Kolb, 1984) and Reflective Practice (Schön, 1983). Experiential learning conceptualizes learning as a continuous cycle consisting of concrete experience, reflective observation, abstract conceptualization, and active experimentation. In design studios, this cycle is realized through direct environmental experience, iterative design production, peer discussion, and continuous refinement of design ideas. Recent research revisiting Kolb's model specifically within foundation design studios demonstrates that reflective observation and studio critique play a central role in transforming sensory experience into design knowledge (Küçükersen et al., 2026).

Reflection represents another essential dimension of studio pedagogy. Rather than occurring only at the completion of design tasks, reflection is embedded throughout the learning process via instructor feedback, peer critiques, and iterative revisions. Contemporary scholarship increasingly characterizes architectural and landscape design studios as environments where learning emerges through cycles of making, discussing, evaluating, and redesigning. Consequently, reflection should be understood not as a supplementary activity but as a fundamental mechanism through which students develop environmental literacy, critical thinking, and professional judgement (Iranmanesh, 2026). Building upon these theoretical perspectives, this study proposes a Multisensory Studio-Based Learning Model in which sensory walks function as structured pedagogical activities rather than simple field observations. Students progressively transform multisensory experiences into field notes, sketches, symbolic representations, perceptual maps, and reflective discussions. The resulting maps therefore represent not only graphic products but also visible evidence of students' cognitive development throughout the studio process. Accordingly, the proposed framework extends conventional survey-based landscape education by integrating experiential learning, reflective practice, multisensory perception, and perceptual mapping into a single pedagogical sequence. Unlike traditional visually oriented site analyses, this framework encourages students to interpret urban environments through the interaction of multiple sensory dimensions, thereby strengthening environmental awareness, spatial reasoning, design communication, and evidence-informed decision-making. The framework is intentionally transferable and may be adapted to landscape architecture, architecture, urban design, and other studio-based design disciplines (Kee, et al., 2024).

In summary, the role of senses in experiencing urban environments has been increasingly recognized across disciplines. Mapping these experiences, which constitute an essential input for urban design, is crucial for shaping future visions. Unlike previous studies that mostly focused on visual, auditory, or olfactory aspects of green spaces, this study aims to evaluate all senses together within the texture of a street.

RESEARCH DESIGN AND METHODS

Research Design

This study adopted a qualitative educational case study design to investigate how multisensory studio-based learning contributes to landscape architecture students' understanding and representation of perceptual landscapes. Rather than evaluating the urban street itself, the research focused on the educational process through which students experienced, interpreted, and visualised environmental perception within a studio setting. The study was grounded in experiential learning theory (Kolb, 1984), reflective studio pedagogy (Schön, 1983), and multisensory environmental perception. Accordingly, the proposed learning model combined field-based sensory exploration with iterative studio activities, enabling students to transform direct environmental experiences into graphical representations through observation, discussion, reflection, and visualisation. Based on this research design, the study focuses on how multisensory environmental observations are identified, documented, and transformed into perceptual landscape representations within the studio process. Particular attention is given to both the representational process and the recurring or divergent sensory-spatial patterns emerging across student outputs. Accordingly, the study addresses the following research questions:

RQ_1. How do landscape architecture students identify and document visual, auditory, olfactory, tactile, and gustatory characteristics of an urban environment through multisensory walks?
RQ_2. How are students' multisensory observations transformed into perceptual landscape representations through the iterative studio process?
RQ_3. What recurring and divergent sensory-spatial patterns emerge across students' individual perceptual landscape maps?

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The research was conducted as part of a fourteen-week undergraduate landscape architecture studio and followed the integrated conceptual and pedagogical framework presented in Figure 1.

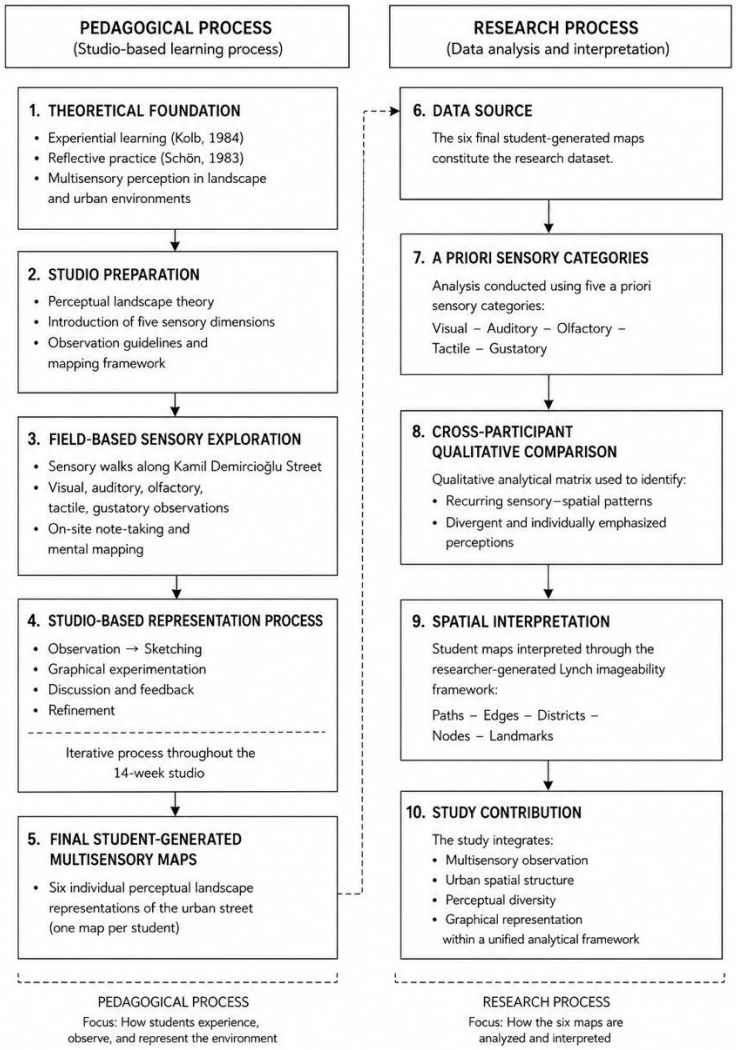

Figure 1. Research design and pedagogical workflow adopted in the multisensory studio-based learning framework. The figure illustrates the sequential relationship between theoretical preparation, field-based sensory exploration, reflective studio learning, perceptual landscape mapping, and the educational outcomes developed throughout the fourteen-week landscape architecture studio.

Participants

The participants consisted of six undergraduate students enrolled in the Department of Landscape Architecture at Kastamonu University. All participants attended the same studio course and voluntarily completed every stage of the multisensory learning process. Rather than aiming for statistical generalization, the study sought to examine in depth how students developed perceptual awareness through repeated studio experiences. Therefore, the relatively small participant group is consistent with qualitative educational case study research and studio-based pedagogical investigations.

Studio-Based Learning Process

The educational process was organized as a fourteen-week iterative studio sequence (Figure 1). During the initial stage, students were introduced to perceptual landscape theory, multisensory environmental perception, and methods of sensory observation. This

theoretical preparation was followed by guided sensory walks conducted within the selected urban street.

Throughout the semester, students repeatedly documented visual, auditory, olfactory, tactile, and gustatory experiences using structured observation sheets, field notes, and freehand sketches. Weekly studio critiques encouraged students to compare their observations, discuss alternative interpretations, and refine their graphic language through reflective dialogue.

As the semester progressed, individual observations were gradually transformed into symbolic representations and comprehensive perceptual landscape maps. The final maps therefore represented the cumulative outcome of iterative learning rather than a single design product.

Study Area

The study was conducted along Kamil Demircioğlu Street**,** located in the city centre of Kastamonu, Türkiye. The street was selected because it represents one of the city's most rapidly developing urban corridors and contains diverse land-use characteristics, including residential, mixed-use, educational, commercial, recreational, and religious functions.

The coexistence of natural and built landscape elements, pedestrian activity, commercial functions, traffic intensity, and open views created a highly heterogeneous sensory environment suitable for multisensory observation. Such diversity enabled students to experience multiple environmental stimuli while examining the relationships between spatial characteristics and human perception.

Data Collection

Data were collected through repeated sensory walks conducted along Kamil Demircioğlu Street during the studio period. During each walk, students systematically observed and documented five sensory modalities, visual, auditory, olfactory, tactile, and gustatory, using structured observation sheets, field notes, and freehand sketches.

As part of the studio-based perceptual mapping procedure, students also used five-point rating scales to evaluate sensory qualities such as pleasantness, intensity, diversity, comfort, and environmental preference. These ratings were used by the students as an intermediate evaluation tool to translate their sensory observations into graphical representations, including variations in symbol size, emphasis, and other visual characteristics in their individual perceptual landscape maps. The individual numerical ratings were used as working materials during the mapping process and were not included in the research dataset; consequently, they were not subjected to descriptive or inferential statistical analysis. Accordingly, the rating procedure was treated as part of the perceptual mapping process rather than as a quantitative component of the research design.

The sensory observation protocol was structured according to predefined criteria derived from the relevant perceptual landscape literature. Visual landscape observations focused on perceptual qualities such as naturalness, diversity, coherence, openness, mystery, perspective, safety, order, topography, scenic beauty, and recreational value (Kaplan & Kaplan, 1989; Tveit et al., 2018). Auditory observations addressed the type, spatial distribution, and perceived intensity of sounds within the street environment (Kang & Schulte-Fortkamp, 2016). Olfactory observations focused on the perceived pleasantness, frequency, and intensity of odours (Henshaw, 2014; Ayan Çeven & Belkayalı, 2023). Tactile observations considered perceived environmental textures and material characteristics, including soft–hard and fine–medium–coarse qualities, whereas gustatory observations focused primarily on edible plant species and food-related spaces encountered along the street. These predefined sensory criteria provided a common observational framework for the six students while allowing individual differences in sensory perception to be documented through field notes, sketches, ratings, and subsequent perceptual mapping.

Following each field session, students discussed their observations in the studio environment and compared similarities and differences in sensory perception. Instructor feedback and peer discussions supported the refinement of graphical representations and encouraged students to articulate their individual multisensory observations through perceptual mapping. The sensory observations and resulting representations were revisited and progressively refined throughout the 14-week studio process.

Data Analysis

The analysis focused on the six final student-generated multisensory perceptual landscape representations. Although structured observation sheets, field notes, freehand sketches, and five-point perceptual ratings were used by students during the studio process to develop their representations, these intermediate materials were not collected as research data and were therefore not included in the researcher's analysis.

The six representations were analyzed through a systematic qualitative comparison. First, each representation was examined individually according to five a priori sensory categories—visual, auditory, olfactory, tactile, and gustatory. Within these categories, the analysis considered the sensory characteristics represented, their spatial associations with urban functions and environmental features, and the graphical means through which they were communicated. The representations were then compared across students to identify recurring and divergent sensory-spatial patterns. Characteristics represented across multiple student outputs were treated as recurring patterns, whereas differences in sensory emphasis, spatial interpretation, or graphical representation were retained as divergent perceptions rather than treated as analytical inconsistencies.

To make this cross-participant comparison transparent, an analytical matrix was developed linking the five sensory dimensions with recurring sensory-spatial patterns, their spatial and environmental associations, and divergent or individually emphasized representations. Matrix-based qualitative displays provide a systematic means of organising and comparing participant-level evidence across analytical categories (Miles et al., 2020). The resulting matrix is presented in the Findings section and provides an explicit link between the individual student representations and the cross-participant patterns reported in the study. The identified patterns were subsequently interpreted in relation to the spatial structure of Kamil Demircioğlu Street using Lynch's (1960) imageability framework of paths, edges, districts, nodes, and landmarks. Thus, the analytical process progressed from individual representation analysis to sensory categorization, cross-participant comparison, and spatial interpretation. The five-point ratings used by students during the mapping process were not available as research data and were therefore not subjected to descriptive or inferential statistical analysis.

Given the subjective nature of multisensory perception and the small participant group, analytical credibility was addressed through the consistent application of the same sensory categories to all six representations, systematic cross-participant comparison, and explicit reporting of both recurring and divergent patterns. No independent second coding, inter-rater reliability assessment, or formal participant validation was conducted. Accordingly, the analysis was intended to provide a transparent qualitative interpretation of the student-generated representations rather than to establish statistical reliability or causal evidence of educational effectiveness.

FINDINGS

Educational Process and Observed Progression in Multisensory Representation

Student outputs produced throughout the studio process showed an observable progression from predominantly visual observations toward more integrated multisensory representations. During the initial stages of the studio, students tended to foreground visible and physical characteristics of the street environment in their observations and sketches. In subsequent outputs, auditory, olfactory, tactile, and gustatory elements

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became increasingly incorporated alongside visual observations, resulting in more multidimensional representations of the perceptual landscape.

Repeated sensory walks, studio discussions, and iterative feedback provided opportunities for students to revisit their initial observations and reconsider the relationships between sensory experience and spatial characteristics. Comparisons between earlier observations and subsequent graphical outputs indicated greater differentiation of sensory information and a more explicit spatial representation of non-visual stimuli. Rather than treating individual sensory impressions as isolated observations, later representations more frequently associated sensory stimuli with particular spatial conditions, urban functions, and environmental features.

The studio discussions also provided a setting in which students compared similarities and differences in their sensory observations and reconsidered how these experiences could be communicated graphically. The resulting maps showed increasingly differentiated uses of symbols, lines, forms, and graphical emphasis to represent sensory qualities that could not readily be communicated through conventional visual site-analysis techniques. This observed progression suggests that the combination of repeated sensory observation, graphical experimentation, and studio feedback may have supported students in articulating multisensory characteristics of the urban environment through perceptual landscape representations. These observations should, however, be interpreted as evidence derived from the progression of studio outputs rather than as direct measures of learning effectiveness or competency development. The study did not employ pre- and post-assessments, standardized evaluation rubrics, or independent measures of learning outcomes. Accordingly, the findings indicate an observable development in the complexity and multisensory integration of students' representations but do not establish causal effects of the studio approach on environmental literacy, spatial reasoning, critical thinking, or other educational competencies.

Spatial Framework Based on Lynch's Imageability Analysis

To provide a common spatial framework for interpreting the multisensory observations, Kamil Demircioğlu Street was analysed by the researcher according to Lynch's (1960) five imageability elements: districts, landmarks, edges, nodes, and paths. Commercial, residential, and recreational areas were identified as districts; the mosque, school, and Atatürk monument as landmarks; railings, retaining walls, and building façades as edges; intersections as nodes; and the main pedestrian routes and side streets as paths. This researcher-generated spatial analysis was subsequently used as a reference framework for examining how students associated their multisensory observations with particular spatial characteristics of the street (Figure 2).

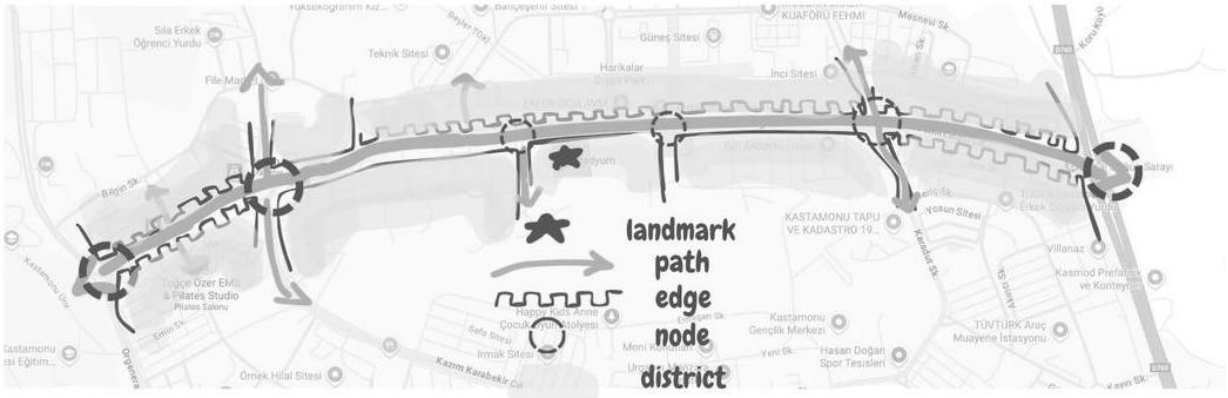

Figure 2. Researcher-generated imageability analysis of Kamil Demircioğlu Street based on Lynch's (1960) framework

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Individual Multisensory Perceptual Landscape Representations

The individual perceptual landscape maps revealed both shared and student-specific approaches to representing multisensory experience. Students employed symbols, lines, graphical emphasis, and variations in size and density to translate visual, auditory, olfactory, tactile, and gustatory observations into spatial representations. Although a common sensory observation framework was used, the graphical expression and relative emphasis assigned to individual sensory characteristics varied across the student outputs. In the first student map, positive visual perceptions were associated particularly with intersections, where greater openness and extended vistas were experienced, whereas areas dominated by dense building stock were represented less positively. Well-maintained modern architectural elements within built-up areas were nevertheless represented positively. The auditory landscape was characterized predominantly by traffic noise, particularly during the peak periods of 08:00–09:30 and 17:00–18:00, with intersections represented as especially noisy locations. Olfactory perceptions were concentrated around food and beverage areas and were associated with food and coffee odours; gustatory representations similarly clustered around these functions. Tactile observations differentiated surface textures, construction materials, and softer ground conditions, with vacant lots particularly emphasized because of their contrasting textures (Figure 3).

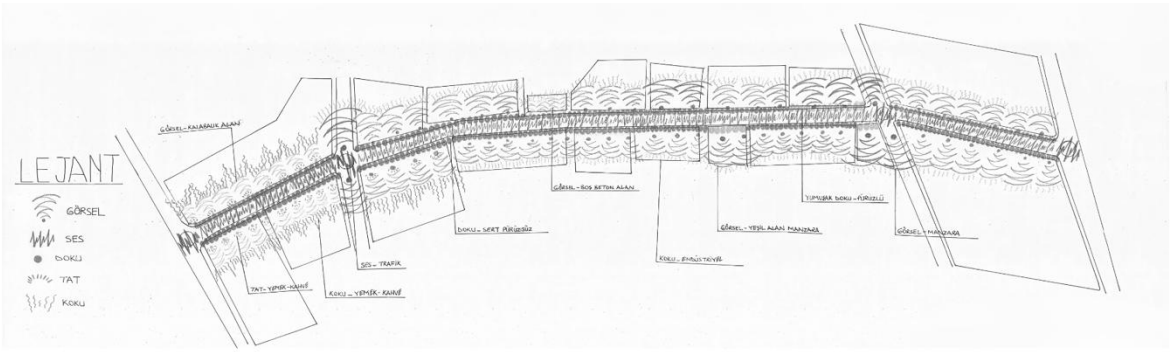

Figure 3. Student – generated Kamil Demircioğlu street illustrating sensory map

In another student's map, visual perception was rated highest in areas where mosque surroundings and modern sports complexes were located, while residential blocks were marked lower. Auditory perception was defined by both traffic noise and other urban sounds such as schoolyard activities and voices from cafés. Olfactory and gustatory dimensions were again concentrated in food-related spaces. Tactile landscapes reflected surface variations along sidewalks and green areas (Figure 4).

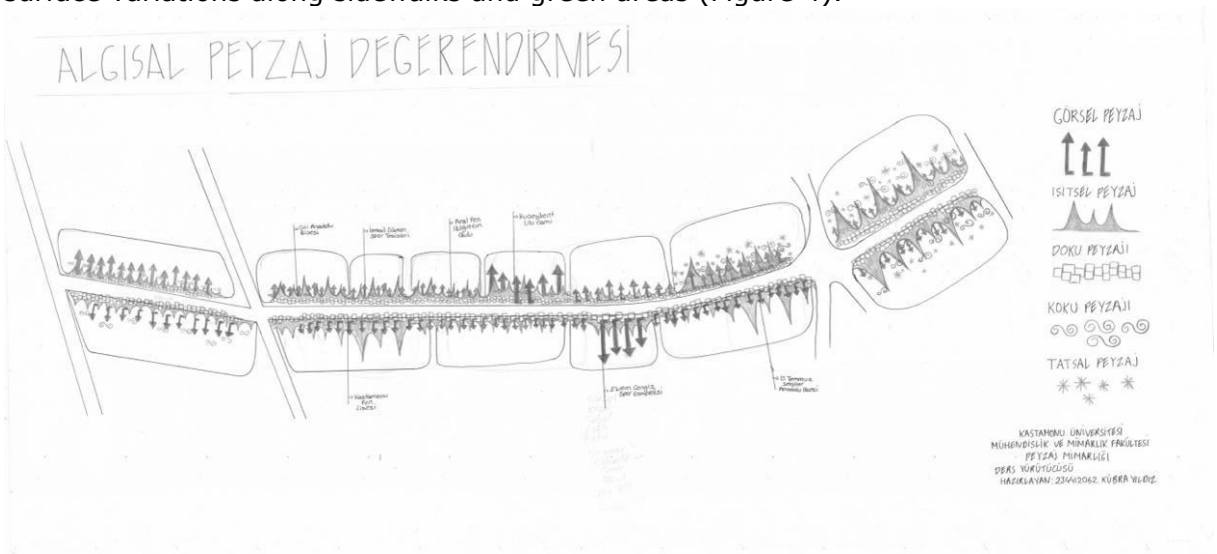

Figure 4. Student – generated Kamil Demircioğlu street illustrating sensory map

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In a third student's evaluation, visual landscapes scored highest in intersections where agricultural and mountain (Ilgaz) views could be seen, with the mosque surroundings again identified as a major landmark. Sounds included traffic, the call to prayer, human voices, and school bells, with the call to prayer emphasized as a symbolic sound. Traffic was represented with darker, thicker lines to indicate its negative impact. Pleasant olfactory and gustatory landscapes were again associated with dining spaces, while tactile landscapes emphasized soft ground textures (Figure 5).

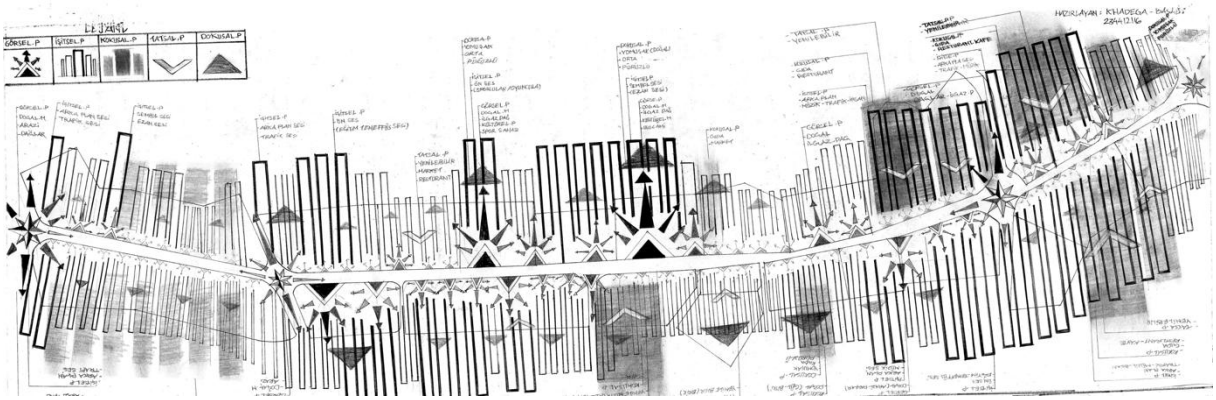

Figure 5. Student – generated Kamil Demircioğlu street illustrating sensory map

In the fourth student map, linear forms and graphical variations were used to represent differences in sensory experience. Areas characterized by lower building density and greater openness were associated with stronger positive visual perceptions. Auditory observations distinguished symbolic, background, natural, and mechanical sounds: human voices in dining areas and school bells were foregrounded, while natural sounds such as rustling leaves were also represented. Food-related olfactory and gustatory experiences were expressed through variations in graphical size and density, and fruit trees within residential gardens were additionally identified as gustatory elements. Tactile representations differentiated rough and hard surfaces in denser built-up areas from smoother and softer textures associated with greener spaces (Figure 6).

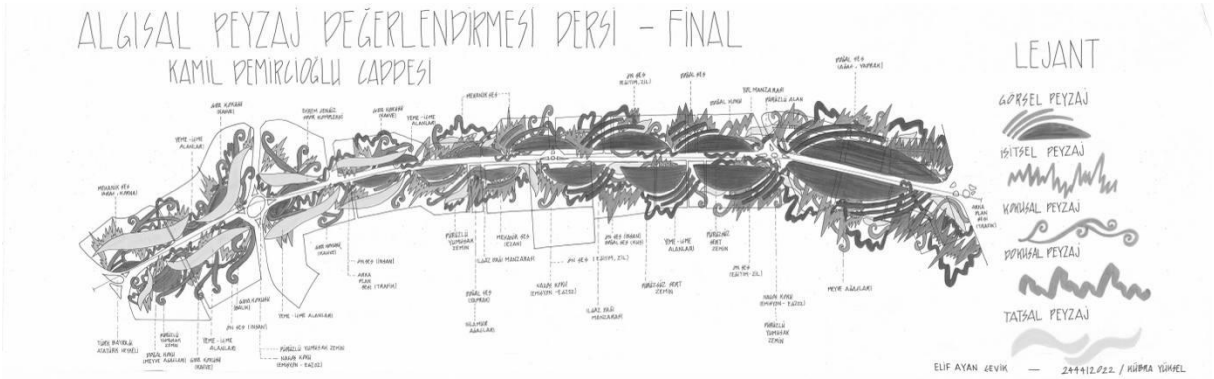

Figure 6. Student – generated Kamil Demircioğlu street illustrating sensory map

Other maps indicated that while food-related olfactory and gustatory perceptions were generally positive, visual quality was rated lower in highly built-up areas. Specific edible plant species (e.g., *Malus pyrus*, *Prunus* sp.) were also recorded in single-house gardens. Auditory landscapes consistently identified traffic as a negative factor, while tactile landscapes highlighted differences between paved urban surfaces and green areas (Figures 7).

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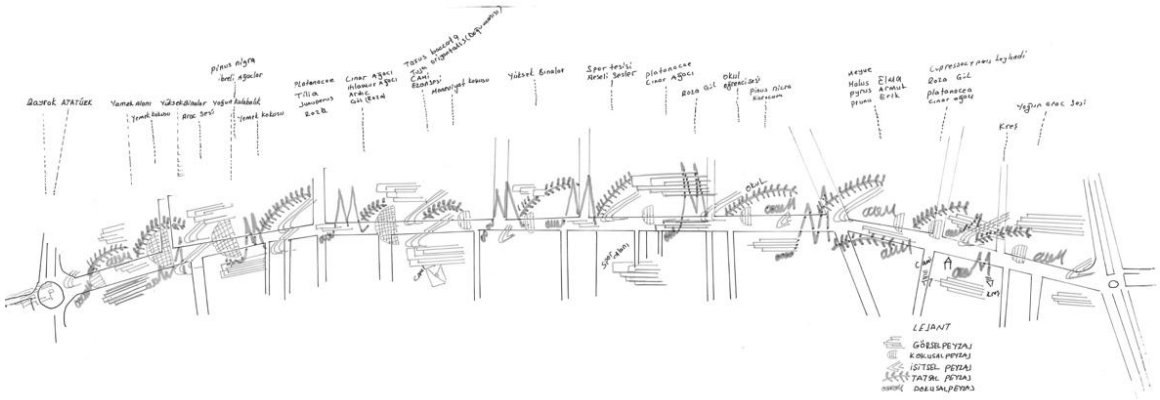

Figure 7. Student – generated Kamil Demircioğlu street illustrating sensory map

When student maps were combined, three distinct perceptual zones emerged from the imageability analysis. The eastern section, adjacent to the university road, was identified as Zone 1, where food and beverage functions dominated sensory experiences. Visual landscapes in this area were marked negatively due to building density, signage variety, and irregular thresholds, while auditory landscapes were negatively impacted by traffic congestion. However, olfactory landscapes were perceived positively, largely because of cafés and third-wave coffee shops. Tactile landscapes, by contrast, were weakened by the diversity of building textures (Figure 8).

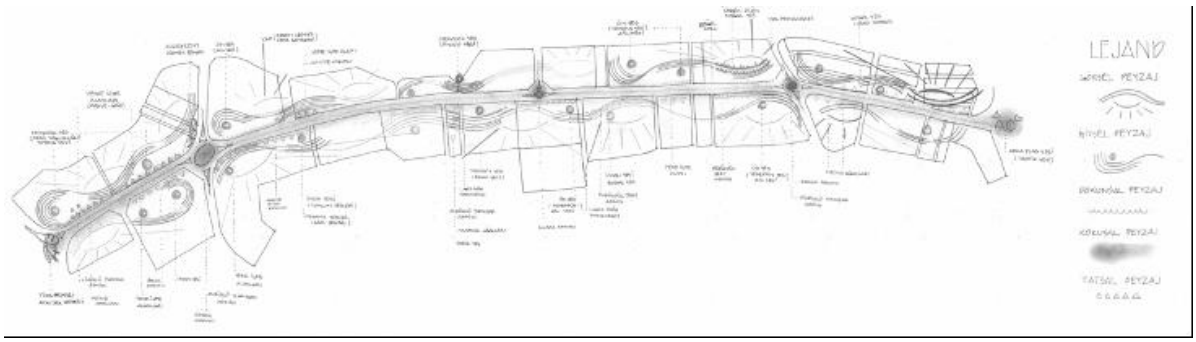

Figure 8. Student – generated Kamil Demircioğlu street illustrating sensory map

From the perspective of sustainable development goals, the findings revealed that sensory experiences are directly related to dimensions of sustainability. For instance, the dominance of traffic noise in auditory landscapes is linked to adverse health and well-being impacts, resonating with SDG 3 (Good Health and Well-being). The concentration of olfactory and gustatory landscapes in food-related areas reflects social vibrancy and economic sustainability, aligning with SDG 11 (Sustainable Cities and Communities). Tactile diversity demonstrates the importance of inclusive and comfortable design at the micro-scale. Thus, multi-sensory mapping offers not only academic learning practice but also a concrete tool for sustainable planning.

Cross-Participant Multisensory-Spatial Patterns

Following the individual examination of the student maps, a systematic cross-participant comparison was conducted to identify recurring and divergent sensory-spatial patterns across the six student outputs. Table X presents the analytical matrix derived from this comparison, documenting both shared sensory-spatial patterns and variations in students' perceptions and graphical representations (Table 1).

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Table 1. Cross-participant analytical matrix of recurring and divergent multisensory-spatial patterns identified in student perceptual landscape maps

Sensory dimension	Recurring sensory-spatial patterns	Main spatial/environmental associations	Divergent or individual representations
Visual	Positive visual perceptions were repeatedly associated with greater openness, extended views, natural or agricultural scenery, and distinctive spatial elements. More densely built and enclosed areas tended to be represented less positively.	Intersections; open areas; agricultural and mountain views; mosque surroundings; sports areas; residential and built-up areas	The visual element receiving greatest emphasis differed among students. Some foregrounded distant natural views and vistas, whereas others emphasised the mosque, sports complexes, modern architectural elements, or general spatial openness.
Auditory	Traffic emerged as the most consistently represented negative auditory stimulus across the student maps. Human activities and function-related sounds also contributed to the auditory character of the street.	Main traffic routes; intersections; school surroundings; cafés and food-related areas; activity nodes	In addition to traffic, individual students emphasised different sound sources, including schoolyard activity, school bells, human voices, café activity, the call to prayer, and natural sounds such as rustling leaves. Some maps also differentiated foreground, background, symbolic, natural, and mechanical sounds.
Olfactory	Positive olfactory perceptions were repeatedly concentrated around food and beverage functions, particularly where food and coffee odours were encountered. Vegetation also contributed to more localised olfactory experiences.	Cafés; restaurants and dining areas; food-related commercial uses; vegetation and residential gardens	The relative prominence and spatial extent of smell sources varied among students. While food-related smells were dominant in several representations, some maps also foregrounded vegetation and plant-related sensory characteristics.
Tactile	A recurring contrast was observed between hard or paved urban surfaces and softer, greener or more natural surfaces. Differences in material and ground texture constituted a major component of tactile representation.	Sidewalks; paved areas; construction materials; vacant lots; green areas; soft ground surfaces	Students varied in the level of tactile differentiation represented. Some focused primarily on transitions between paved and green areas, whereas others distinguished rough–hard surfaces from smooth–soft textures or emphasised vacant lots and material changes.
Gustatory	Gustatory perceptions were repeatedly associated with food and beverage functions. Edible vegetation represented an additional but more spatially specific source of gustatory experience.	Cafés; restaurants and dining spaces; food-related commercial areas; residential gardens containing edible plants	Food-related functions were widely represented, whereas edible plants appeared more selectively in individual maps. Fruit trees and species such as *Malus* and *Prunus*spp. were identified in some residential gardens.

The cross-participant comparison revealed particularly clear convergence in three sensory-spatial relationships. First, traffic was consistently represented as a negative auditory component of the street, although the range of additional sound sources varied among students. Second, food and beverage functions formed the principal spatial focus of both olfactory and gustatory perceptions, indicating a close relationship between land use and these sensory dimensions. Third, tactile representations repeatedly differentiated paved and hard urban surfaces from greener and softer environments. Visual perceptions displayed comparatively greater variation, although openness, extended views, natural scenery, and distinctive spatial elements were recurrently associated with more positive representations. At the same time, the individual maps retained differences in sensory emphasis, spatial extent, and graphical expression, demonstrating that common

environmental patterns coexisted with subjective interpretations of the same street environment. These recurring and divergent sensory-spatial patterns formed the analytical basis for the subsequent synthesis of the individual maps into composite multisensory representations of Kamil Demircioğlu Street.

DISCUSSION

Multisensory Observation and Documentation of the Urban Environment

The first research question examined how landscape architecture students identified and documented visual, auditory, olfactory, tactile, and gustatory characteristics of an urban environment through multisensory walks. The six student-generated representations showed that sensory observations were associated with identifiable spatial characteristics, urban functions, and environmental features. Visual perceptions were frequently related to openness, distant or natural views, built density, and distinctive spatial elements. Auditory representations were strongly influenced by traffic and activity-related sounds, whereas olfactory and gustatory experiences were concentrated primarily around food and beverage functions. Tactile representations differentiated between paved or hard surfaces and softer, vegetated environments. At the same time, the relative emphasis placed on these characteristics differed among students. These findings correspond with a growing body of research that conceptualizes urban perception as a multisensory relationship between people and spatial form rather than as a predominantly visual process. Kavee and Flanigan (2025), in their systematic review of multisensory perception and urban form, argue that sight, sound, smell, touch, and taste can be related to identifiable characteristics of the built environment and propose an extension of Lynch's urban-form taxonomy across all five senses. This is particularly relevant to the present study because the researcher-generated Lynch analysis provided a spatial reference for interpreting the students' multisensory representations. The findings suggest that elements such as nodes, paths, landmarks, and districts may function not only as components of visual legibility but also as spatial settings within which different sensory experiences become salient.

The auditory dimension provided one of the clearest examples of this sensory–spatial relationship. Traffic was repeatedly represented as a negative auditory characteristic, particularly around intersections and traffic-dominated sections of the street. This finding is consistent with soundscape research demonstrating that acoustic experience is influenced by the interaction between sound sources, spatial conditions, and perceptual context rather than by sound level alone. Li et al. (2022), examining public spaces alongside an elevated road, found that quietness, pleasantness, eventfulness, and distinctiveness contributed to soundscape evaluation and that spatial characteristics could be used to predict perceived soundscape quality. The recurring identification of traffic in the present student maps therefore reflects a relationship between urban function, spatial configuration, and auditory experience that is well established in contemporary soundscape research. Importantly, auditory experience cannot be considered independently of the visual environment. Jo and Jeon (2021) demonstrated that overall environmental assessment in urban parks emerges through interactions between soundscape and landscape characteristics, while Zhou et al. (2024) found that visual landscape satisfaction was positively associated with soundscape evaluation and that architectural aesthetics made a particularly strong contribution to this relationship. Such findings help explain why the student representations frequently connected traffic, intersections, built density, openness, and environmental views rather than depicting sensory stimuli as spatially isolated phenomena. The maps can therefore be interpreted as representations of sensory–spatial relationships rather than independent inventories of individual sensory modalities.

Olfactory observations similarly showed a strong relationship with urban function. Food and beverage areas repeatedly emerged as important olfactory environments, particularly through food and coffee-related smells. This corresponds with smellscape research demonstrating that urban odours are spatially and temporally structured and closely related to environmental characteristics and everyday activities. He et al. (2022), using a refined smellwalk approach, demonstrated that smellscapes display identifiable spatial and temporal patterns and that landscape spatial characteristics influence olfactory experience.

The findings of the present study extend this relationship from an urban park context to a mixed-use street, where commercial food functions became prominent generators of olfactory and gustatory experience.

The tactile findings are also relevant because touch remains comparatively underrepresented in urban-perception research. Parker et al. (2024) emphasize that tactile and haptic characteristics of urban environments can be explored through walking but require deliberate attention to surface, bodily movement, materiality, and kinesthetic experience. In the present study, students differentiated paved, rough, hard, soft, and vegetated surfaces within their representations. Although these observations were less spatially extensive than visual or auditory information, they demonstrate that structured multisensory walking can direct attention towards environmental characteristics that conventional visually oriented site surveys may not systematically record.

The contribution of the present findings should therefore not be understood as demonstrating previously unknown relationships between traffic and sound, food and smell, or vegetation and tactile experience. Rather, the contribution lies in incorporating these sensory dimensions simultaneously into a landscape architecture studio exercise and requiring students to spatially represent them within the same urban environment. In this respect, multisensory walking expanded the conventional scope of site observation by making non-visual environmental characteristics explicit components of landscape survey and representation.

Transforming Multisensory Observation into Perceptual Landscape Representation

The second research question examined how students transformed multisensory observations into perceptual landscape representations through the studio process. The final maps show that students translated sensory experiences into graphical systems using symbols, lines, forms, scale, density, and other forms of visual emphasis. These graphical devices were used not only to identify sensory stimuli but also to communicate their location, relative prominence, perceived character, and relationship with environmental features. Consequently, the maps functioned as spatial translations of multisensory experience rather than conventional inventories of physical site elements.

The challenge of translating non-visual experience into visually communicable spatial information has become increasingly important in contemporary environmental-perception research. Zhuang et al. (2024), for example, investigated the relationship between auditory and visual place perception through soundscape-to-image generative modelling. Although their computational approach differs fundamentally from the hand-generated symbolic mapping used in the present study, the underlying representational problem is comparable: sensory information that is not inherently visual must be transformed into a form that allows spatial characteristics and place experience to be communicated. The student-generated maps demonstrate a pedagogical version of this process in which graphical abstraction becomes a means of externalizing intangible sensory information.

This transformation also corresponds with established characteristics of design-studio pedagogy. Hettithanthri and Hansen (2022), based on a review of 60 studies, characterize conventional design studios as learning environments shaped by learning-by-doing, interaction, collaboration, and reflective practice. Hettithanthri et al. (2023) further demonstrate that contextual observation and site analysis constitute important early components of the architectural design process and emphasise the relationship between context, users, and design thinking. Similarly, Süner-Pla-Cerdà et al. (2025), examining studio education across architecture, design, and planning, identify experiential learning, frequent student–instructor interaction, reflective dialogue, and project production as characteristic elements of studio pedagogy.

The present studio process situated multisensory environmental observation within this iterative pedagogical structure. Students physically experienced the street, differentiated sensory characteristics, experimented with graphical means of representing them, and refined their final representations through the studio process. This sequence is consistent with experiential approaches to design education in which bodily engagement with space is treated as a component of design learning. Yüksel and Uyaroğlu (2021), for example, applied Kolb's experiential learning framework to basic design education and demonstrated the relevance of direct bodily experience for understanding body–space relationships. In the present study, bodily experience was extended from the visual and spatial dimensions of design to the simultaneous consideration of sound, smell, touch, and taste.

The use of five-point perceptual ratings should also be interpreted within this representational process. The ratings were used by students as working tools for differentiating sensory qualities and informing graphical emphasis; they were not collected by the researcher as quantitative data. Their role was therefore pedagogical and representational rather than statistical. This distinction is important because it situates rating, sketching, symbol development, and mapping as successive tools through which students translated sensory experience into visual-spatial information. However, the final representations cannot independently demonstrate that the studio improved environmental literacy, spatial reasoning, critical thinking, or graphical communication. The study did not include pre- and post-assessments, standardized evaluation rubrics, independent assessments of student performance, or longitudinal measures of competency development. Accordingly, the observed differences between the studio process and the final representations should not be interpreted as causal evidence of educational effectiveness. The pedagogical contribution is therefore more specific. The study documents a structured workflow through which multisensory environmental experience can be incorporated into landscape architecture studio representation. Sensory observation, spatial association, graphical translation, studio reflection, and final perceptual mapping were connected within a single educational sequence. In this sense, perceptual landscape mapping functions as a representational bridge between embodied environmental experience and spatial analysis rather than merely as a final graphical product.

Recurring and Divergent Sensory–Spatial Patterns Across Student Representations

The third research question examined the recurring and divergent sensory–spatial patterns emerging across the six student-generated perceptual landscape representations. Cross-participant comparison revealed particularly clear recurrence in the association of traffic with negative auditory experience and food and beverage functions with olfactory and gustatory experience. Tactile representations repeatedly distinguished hard or paved surfaces from softer and greener environments. Visual perceptions showed comparatively greater differentiation, although openness, extended views, natural scenery, and distinctive spatial elements were repeatedly associated with positive representations.

The recurrence of particular relationships across independently produced maps indicates that some environmental conditions were sufficiently salient to become visible across multiple individual representations. Traffic provides the clearest example. Although students differed in how they graphically represented sound, traffic repeatedly appeared as an undesirable auditory characteristic. This finding is consistent with Li et al. (2022), whose analysis of roadside public spaces demonstrated systematic relationships between spatial characteristics and soundscape evaluation. It also corresponds with Zhou et al. (2024), who showed that the evaluation of acoustic environments is intertwined with the characteristics of the surrounding visual landscape.

The repeated association of food-related functions with smell and taste similarly demonstrates the role of land use in structuring multisensory experience. He et al. (2022) showed that smellscape patterns vary according to landscape composition and spatial

characteristics, supporting the interpretation of odour as a spatial rather than merely sensory phenomenon. In Kamil Demircioğlu Street, cafés, restaurants, and other food-related functions acted as identifiable sensory generators that contributed to both olfactory and gustatory representations. Thus, the student maps reveal how functional land-use patterns may simultaneously contribute to multiple perceptual dimensions. At the same time, the maps did not produce a uniform perceptual reading of the street. Students differed in the elements they foregrounded, the spatial extent assigned to particular sensory experiences, and the graphical techniques through which these experiences were represented. Some maps emphasized distant agricultural or mountain views, whereas others foregrounded architectural landmarks, sports areas, or spatial openness. Auditory representations similarly ranged from traffic-focused mappings to more differentiated representations including school bells, human voices, the call to prayer, café activity, and natural sounds. Tactile interpretations varied from relatively broad distinctions between paved and green areas to more differentiated contrasts between rough, smooth, hard, and soft surfaces.

These differences are theoretically meaningful because multisensory environmental perception cannot be understood solely as a direct response to objectively present environmental stimuli. Kavee and Flanigan (2025) emphasize the complexity of linking sensory perception to urban form, while contemporary multisensory research demonstrates that individual sensory domains also interact with one another. Lai and Ou (2026), for example, found significant interactions among auditory, visual, and olfactory comfort in urban parks, demonstrating that overall environmental comfort cannot be adequately explained through independent sensory assessments alone. Similarly, Foellmer and Tyler (2025) experimentally demonstrated crossmodal interaction between traffic noise and diesel odour: traffic noise increased perceived odour intensity and reduced odour liking. Such evidence reinforces the argument that multisensory environmental experience emerges through relationships among sensory stimuli, spatial context, and individual perception.

From this perspective, divergence between student maps should not automatically be treated as analytical inconsistency. Recurring patterns reveal environmental relationships that became salient across several representations, whereas divergent patterns retain the subjective component of environmental perception. The analytical matrix used in the present study was therefore designed to preserve both forms of information rather than reducing the six representations to a single average or composite perceptual map.

This approach is particularly relevant because the five-point ratings used during the studio process were not available as research data and therefore could not legitimately be aggregated numerically. Cross-participant qualitative comparison offered an alternative means of identifying shared patterns while retaining individual interpretations. Methodologically, this enables multisensory mapping to acknowledge both common sensory–spatial relationships and perceptual diversity within the same environmental setting.

Multisensory Perception and Lynch's Spatial Framework

Across the three research questions, an additional issue concerns the relationship between multisensory perception and urban spatial structure. In the present study, Lynch's (1960) imageability analysis was conducted by the researcher and used as a spatial interpretive framework rather than being produced by the students or treated as a composite sensory map. This distinction allows the spatial organization of the street and the students' perceptual representations to remain analytically separate while enabling relationships between them to be examined. This approach is supported by recent attempts to extend conventional urban-form analysis towards multisensory interpretation. Kavee and Flanigan (2025) explicitly reframe Lynch's taxonomy to encompass all five human senses and argue that urban-form elements can provide a spatial structure for organizing multisensory information. The present study provides an educational application of this emerging

conceptual direction. Intersections operated simultaneously as Lynchian nodes and locations associated with distinctive visual and auditory experiences; commercial areas functioned as districts while also generating olfactory and gustatory experiences; the mosque functioned as a visual landmark while also producing a symbolic auditory component; and paths connected changing visual, auditory, and tactile conditions along the street. The relationship between spatial form and sensory experience is also consistent with Zhuang et al. (2024), whose findings demonstrate that auditory information contains meaningful information about the visual and spatial characteristics of place. Likewise, the audio-visual relationships identified by Jo and Jeon (2021) and Zhou et al. (2024) demonstrate that spatial and sensory qualities should not necessarily be analyzed as independent layers. Together, these studies support an interpretation of urban environments in which spatial organization provides the physical context for multisensory experience while sensory perception adds an experiential dimension to conventional morphological analysis. The contribution of combining these approaches lies therefore not in modifying Lynch's original categories, but in using them as a stable spatial reference against which individual multisensory representations can be interpreted. This allows perceptual landscape mapping to complement conventional imageability analysis: the former reveals how environmental conditions are sensed and differentiated, whereas the latter provides a spatial framework for locating and interpreting these experiences.

Implications for Landscape Architecture Education

Taken together, the findings indicate that multisensory perceptual mapping can broaden the scope of environmental observation and representation within landscape architecture studio education. Conventional site-analysis practices frequently foreground visible and measurable physical characteristics. The approach examined here required students to consider auditory, olfactory, tactile, and gustatory information alongside visual characteristics and subsequently to translate these observations into spatial representations. This approach brings together two bodies of scholarship that are often developed separately. Multisensory environmental research increasingly demonstrates that urban experience emerges through relationships among sensory modalities, environmental context, and spatial form (Kavee & Flanigan, 2025; Lai & Ou, 2026). Design-education research, meanwhile, characterizes the studio as an experiential and iterative learning environment structured through direct engagement, representation, interaction, and reflection (Hettithanthri & Hansen, 2022; Hettithanthri et al., 2023; Süner-Pla-Cerdà et al., 2025). The framework examined in the present study connects these two strands by making multisensory environmental experience the subject of an iterative representational studio process. The educational relevance of the approach therefore lies primarily in expanding what can be observed and represented during landscape survey rather than in demonstrating superior educational outcomes. Sensory walks make environmental characteristics such as traffic sounds, food odours, surface textures, edible vegetation, and other experiential qualities available for explicit spatial interpretation. Graphical mapping then provides a means through which these intangible observations can become discussable components of studio analysis. This distinction is important for positioning the contribution of the study. The findings do not demonstrate that multisensory perceptual mapping is more effective than conventional studio methods, nor do they establish measurable improvements in student competencies. Instead, the study provides evidence that a structured multisensory workflow can be incorporated into a landscape architecture studio and that students can translate sensory observations into differentiated spatial representations. Future studies incorporating pre- and post-assessments, student reflections or interviews, structured evaluation rubrics, independent expert assessment, and larger or comparative student cohorts would be required to determine whether this process produces measurable changes in perceptual awareness, environmental literacy, spatial reasoning, or graphical communication.

Within these boundaries, the principal contribution of the study is the integration of embodied multisensory observation, spatial interpretation, graphical representation, and cross-participant qualitative comparison within a single landscape architecture studio

framework. Rather than positioning perceptual mapping solely as a method for describing the sensory character of an urban street, the study demonstrates its potential as a structured representational approach through which students can explore how environmental experience and spatial structure intersect.

CONCLUSION

This study examined the integration of multisensory perceptual landscape mapping into landscape architecture studio education through an urban street case study. The six student-generated representations demonstrated how visual, auditory, olfactory, tactile, and gustatory observations could be translated into spatial and graphical forms and associated with particular urban functions, environmental characteristics, and spatial conditions. Cross-participant comparison revealed recurring sensory–spatial relationships, particularly between traffic and negative auditory experience, food-related functions and olfactory/gustatory experience, and surface characteristics and tactile perception. At the same time, differences among the individual representations demonstrated that shared environmental patterns coexist with subjective variations in sensory emphasis, spatial interpretation, and graphical expression.

From an educational perspective, the study shows how multisensory observation can be incorporated into a structured landscape architecture studio workflow connecting sensory exploration, spatial interpretation, graphical representation, and reflective studio practice. Rather than treating sensory walking solely as a field-data collection technique, the proposed approach uses multisensory experience as an input for perceptual landscape representation. The researcher-generated Lynch imageability analysis further provided a spatial reference through which the student-generated sensory representations could be interpreted in relation to paths, edges, districts, nodes, and landmarks. In this way, conventional spatial analysis and subjective multisensory experience were retained as distinct but complementary analytical layers.

The principal contributions of the study to perceptual landscape and landscape architecture education literature can be summarized as follows:

- **Expanding landscape site analysis beyond visual dominance:** The framework incorporates visual, auditory, olfactory, tactile, and gustatory dimensions within the same perceptual landscape mapping process, making non-visual environmental characteristics explicit components of landscape observation and representation.
- **Connecting multisensory experience with urban spatial structure:** The combination of student-generated multisensory representations with a researcher-generated Lynch imageability analysis provides a two-layered approach for relating subjective sensory experience to identifiable spatial elements and urban functions.
- **Preserving perceptual diversity while identifying shared patterns:** Rather than merging individual student outputs into a single composite map, the cross-participant analytical matrix identifies recurring sensory–spatial relationships while retaining divergent and individually emphasized perceptions. This enables systematic comparison without reducing subjective sensory experience to an aggregated representation.
- **Integrating multisensory mapping into the studio workflow:** The study positions perceptual landscape mapping as a structured studio-based representational approach linking embodied sensory observation, spatial interpretation, graphical translation, and reflective studio practice rather than solely as a technique for documenting environmental conditions.

These contributions should nevertheless be considered within the methodological boundaries of the study. The research involved six undergraduate students from a single landscape architecture programme and focused on one urban street. Moreover, the research dataset consisted of the final student-generated perceptual landscape representations; intermediate observation sheets, field notes, sketches, and five-point ratings used during the studio process were not collected as research data. The study

therefore does not provide direct evidence of changes in environmental literacy, spatial reasoning, critical thinking, or graphical competence, nor does it establish the educational effectiveness of the approach relative to conventional studio methods. Future research should examine the framework with larger and comparative student groups and incorporate pre- and post-assessments, reflective accounts, interviews, structured evaluation rubrics, or independent assessments to evaluate educational outcomes more directly.

Overall, the study positions multisensory perceptual landscape mapping as a transferable studio-based framework that complements conventional visually oriented landscape analysis. Its principal value lies in connecting embodied multisensory experience, urban spatial structure, individual perceptual diversity, and graphical representation within a common analytical and educational framework. In doing so, the study provides a methodological basis for further research into how multisensory approaches can be incorporated into landscape architecture education without reducing the subjective character of environmental perception.

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