

# A COMPARATIVE ANALYSIS OF THE COGNITIVE DIFFERENCES IN WAYFINDING AMONG LOCAL AND INTERNALLY MIGRANT STUDENTS IN URBAN ENVIRONMENTS

## A trip from BUET campus to Dhaka New Market

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**Abstract:** Urban design is the art of creating spaces that are high-quality, sustainable, and appealing for living, working, and relaxing. Effective urban design ensures legibility, aiding people in navigating their environment. By incorporating wayfinding studies in urban place-making, we can create inclusive spaces that are not only functional and efficient but also enjoyable and safe for everyone. With many students migrating to Dhaka city from various parts of Bangladesh for higher education and job opportunities, this research examines the differences in cognitive abilities between local and internal migrant students in perceiving the city. The study targets first-year students from the Department of Architecture at Bangladesh University of Engineering and Technology (BUET), using detailed questionnaire survey, inter-place distance judgment, and sketch map analysis. Utilizing Kevin Lynch's five elements as a framework, the research identifies the extent of different urban elements helping both the groups enhancing their spatial cognition and facilitating unrestricted movement. Results reveal significant differences in mental mapping between locals and newcomers. This study provides valuable insights for urban designers, helping them develop design guidelines to create a legible city that meets the needs of both residents and newcomers.

**Keywords:** Migrant students; spatial cognition; sketch map; legibility; wayfinding.

## 1. Introduction

Dhaka is one of the fastest growing megacities in the world with an overall population of approximately 30million (Khaleda et al., 2017). Due to this rapid urbanization and economic growth, the urban form of the city is gradually changing. As a capital, diverse facilities and opportunities are spurring up centring the city and attracting many migrants towards the city, both for employment and educational pursuits. Every year, thousands of students from across the country move to Dhaka to pursue higher education (Alam & Mamun, 2022). A search by Amin (2010) finds that 15.8% of total migrants move to Dhaka for educational purposes. According to statistical data (BBS, 1994), there were almost 41.59% and 53.56% residential students in Dhaka university and Bangladesh University of Engineering and Technology (BUET), respectively. As confirmed by Department of Student Welfare BUET, in the academic year of 2020-21, about 44% of total admitted students in BUET were from outside of Dhaka. These students must survive on their own to continue their education (Ali et al., 2021). When in an unfamiliar city, it becomes quite challenging for newcomers to navigate to various places to carry out their daily activities. This challenge becomes further complicated by cultural practices, as most youngsters are accompanied by their parents until they reach high school.

Due to migration, the execution of urban strategies has been volatile, as the city continually undergoes changes to accommodate these migrant populations (Swapan et al., 2017). Migrants, particularly newcomer students (focus of this study) find it difficult to identify the intricate pattern and layering of the urban setting and thus they actively seek for point of reference to understand the city. To comprehend the dialect between the city and its residents and migrants, it is essential to identify how people acquire, store, organize and recall locations, arrangements, and distances, which are key aspects of spatial cognitive capacity. This understanding will help in creating effective urban spaces which facilitate ease of movement.

Previously, the impact of numerous variables such as spatial ability, age, gender, stage of life and other personal characteristics, influencing spatial cognition of a city dweller has been studied thoroughly (Levine et al., 2016; Proulx et al., 2016; Verghote et al., 2019). However, little has been mentioned about how the migrants react to individual spatial elements or to what extent these elements contribute to the city's legibility for a newcomer. Thus, this paper aims to identify the differences in cognitive capacity between local and migrant students by examining urban spatial elements that help them construct a clearer image of the city, ensuring legibility.

## 2. Literature Review

Contemporary urban design strategies extend beyond the boundaries of physical space. They consider space not only as an

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aesthetic entity but also as a behavioural setting that offers diversified activities for the success of the space (Carmona et al., 2003). Numerous theoretical and design concepts have made attempts to create an ideal or at least optimal built environment for human beings. However, most of the concepts such as, Ideal cities of the Renaissance, Howard's "Garden City, Le Corbusier's "City of Tomorrow" etc. have almost entirely disregarded the individual's perception and experience of a space (Zmudzinska-Nowak, 2003)

Although city design is considered to be a temporal art, its sequences are changed depending on the diverse range of people and their subjective experiences. Therefore, ease of movement and legibility should be considered when it comes to urban design, as guided by the DTER/CABE, where the former one ensures easy mobility and the later one refers to clearer understanding of the particular space (CABE, 2000). Kevin Lynch (1960) in his book chapter "The Image of the City", mentioned how a city can be arranged in a coherent pattern for the ease of the perceiver, referring to the physical perspective as Legibility. While roaming around a city, people use various cues and some wayfinding devices like maps, street numbers, billboards, etc. which help them find strategic links to create their environmental image. This makes legibility an important aspect of a city while considering environments at an urban scale and complexity to create an intensified individual experience. Lynch's concept of creating a mental image of a city involves five physical elements: Paths, edges, districts, nodes, and landmarks. Paths are considered as the predominant element along which an individual moves through the city whereas edges serve as boundaries between two different areas but are not paths themselves, however, they may, sometimes, be intersected by paths. Districts are considered chunks of the city having common identifying features whereas nodes can be strategic focal points of a city such as the convergence of multiple paths, or a cornered enclosed square. Unlike nodes, landmarks are also a notable point of reference which are considered as distinctive features and visible from distant places. These elements mostly help city dwellers generate cues to ensure a better understanding of the setting and easier navigation through the urban spaces. Additionally, landscaping and vistas can also establish visual links or indicate the continuation of a route toward a specific destination and the clarity of these indications enhances an individual's sense of safety (CABE, 2000). Several literatures have been constructed depending on Lynch's theory, mostly considering these elements collectively, although the impacts of individual elements on human perception, especially migrants, are yet to be explored. Some studies acknowledge the role of immigrants in urban design and planning (Kärholm et al., 2023; Çağlar & Schiller, 2018), although the primary focus is limited to international migrants only.

This research, thus, aims to undertake a comprehensive examination of Kevin Lynch's theory, and analyse the impact of each element—path, edge, node, district, and landmark—on urban legibility for local and internally migrated students with an objective to bridge the gap between design and usability, ensuring that urban environments serve the needs of their diverse populations effectively.

### 3. Methodology

To identify the wayfinding strategies, it is necessary to understand individual's spatial knowledge. Thus, the methods of spatial cognition assessment have been employed in this research. Although different methods are available to study spatial cognition, validity of deploying one method is questioned mostly (Gifford, 2007). That is why mixed methods have been used to collect data from the participants which includes estimating distance between pairs of places, scaled position plotting and constructing sketch map.

#### 3.1. PARTICIPANT GROUP AND STUDY AREA SELECTION

The major challenge of this research was to extract accurate representation of an individual's spatial knowledge. To reduce the number of variables influencing spatial cognition such as personal characteristics, the students of Level 01 Term 02 of Department of Architecture BUET have been chosen as the participant group. As they belong to the same age group (mostly 19-21 years old), it eliminates the chances of cognitive differences and spatial ability caused by age difference and professional background.

The journey from BUET campus premises to Dhaka New Market (Figure 1) has been selected for the study as almost 63% participants of the study group use this route (BUET pocket gate, Polashi - Nilkhet Road- Dhaka New Market 2no. Gate) at least once in a month and the rest of them move more frequently; both the local students and the migrant students visit the marketplace in order to avail their stationary supplies and other necessities, mostly after their class finishes, as recorded from the pilot survey (Figure 2).

#### 3.2. DATA COLLECTION METHOD

A well-structured questionnaire with a set of 17 questions has been formatted to extract data from the study group. It has been pre-tested on around 20 students from other semesters in the first phase to check the interpretive quality of the questionnaire and avoid ambiguity, if any. After that, the selected study group has been made aware of the research and details of the study objectives have been shared with them to eliminate confusion. Although all the students from the class have given prior consent, 46 out of 57 students have taken part in the questionnaire survey. The survey has been conducted in their habitual campus setting.

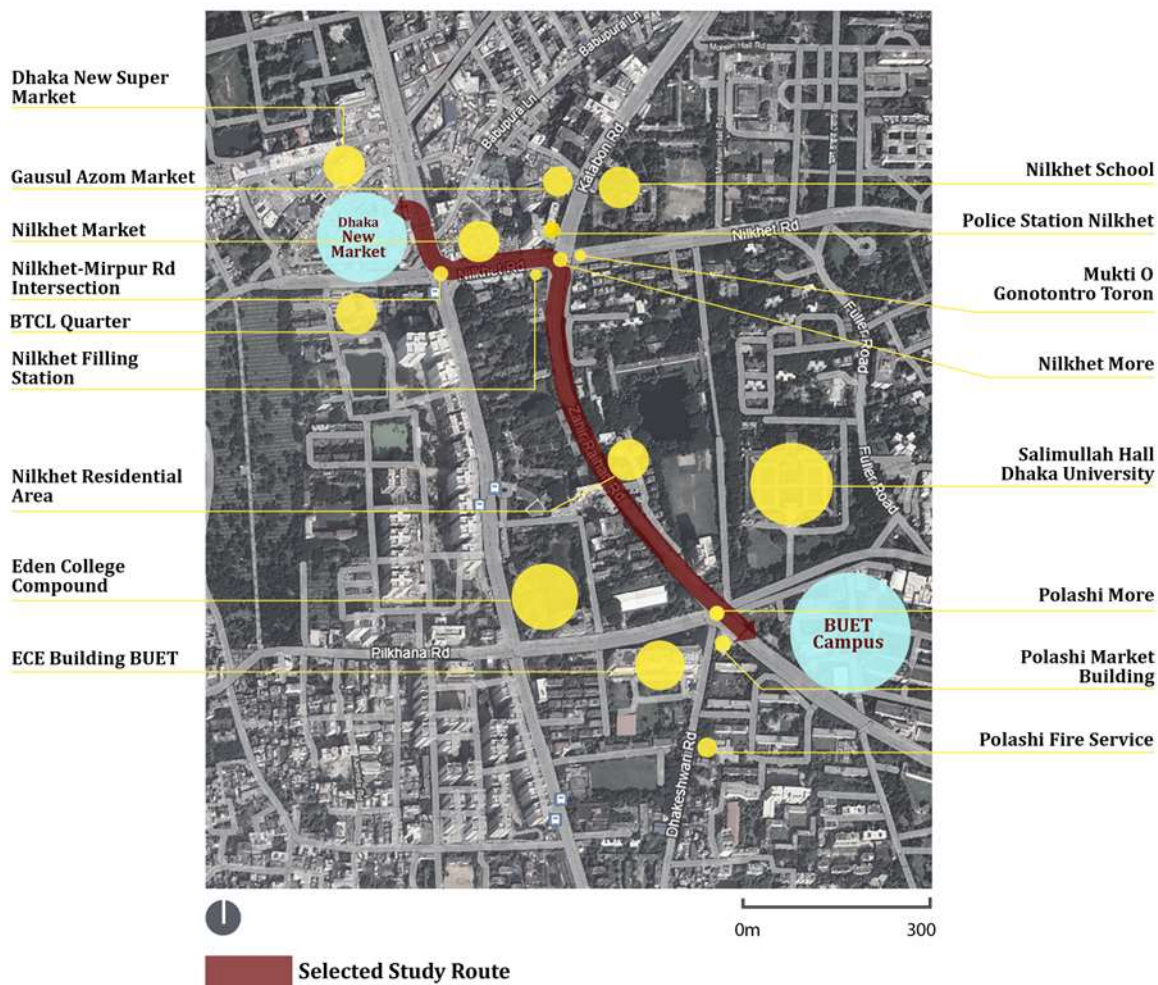


Figure 1, Site map (Source: Google Map, edited by Author)

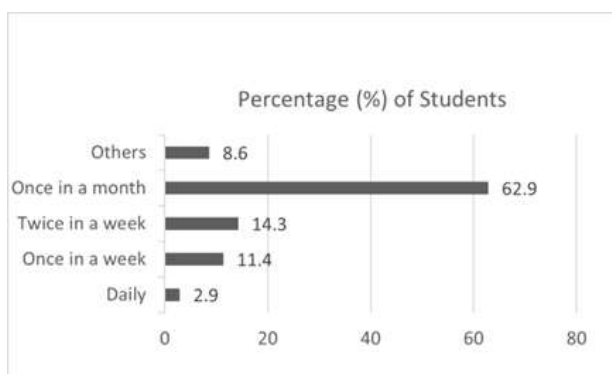


Figure 2, Frequency of visiting Dhaka New Market (Pilot Survey)

The questionnaire consisted of three sections: basic demographic data, interaction and familiarity with the route, and providing mental maps both in written format and in sketches. The introductory section presented questions related to their personal information like gender, current address, etc. In the following section, they were asked questions in detail related to their encounters with the study route such as, frequency of visit, mode of transport, purpose, etc. In the concluding section, they were instructed to transfer their mental maps of the route in multiple formats (position plotting, sketch, and numerical explanation), etc. The legitimacy of sketch maps as a research method is often questioned due to individual's drawing ability or problems with translating a large place into a small piece of paper. As the participant group is at the end of their level 01 curriculum, they have already gone through intensive training in interpretive scaled drawing including improved sketch quality which ensures the acceptability of the maps drawn by them.

### 3.3. DATA EXTRACTION

While transcribing the collected data, 11 responses were discarded because some respondents have identified alternative routes in their sketch maps, some have not completed the questionnaire, and some provided inconsistent data, found during assessment. After sorting the data, 35 responses were recorded systematically. Among them, 57% of the participants were permanent residents of Dhaka, i.e., local students, and the remaining 43% were students who had come to the capital city from rural and other urban areas for higher studies (*Table 1*).

Table 1: Numerical distribution of the participant group

	Total (no.)	Male(M)	Female (F)
Local*	20	7	13
Migrant**	15	10	5

\*Local= Students who lives in Dhaka and completed their previous education in Dhaka

\*\*Migrant= Students who come to Dhaka for higher studies after completing their previous education outside Dhaka

The collected data has been recorded in a Microsoft Excel workbook to identify the co-relation between the variables. Responses collected from open-ended questions have been coded and then grouped according to similar identifying characteristics to decipher the underlying patterns. During data extraction from the sketch-maps, distortions have been ignored and only the identified spatial elements have been considered while comparing the maps.

## 4. Findings

The recorded data has yielded several major observations which can be analysed under the following categories. These sections highlight significant patterns and differences in spatial cognition and wayfinding strategies between local and migrant students. By analysing these outcomes, we can pinpoint specific urban elements that either facilitate or hinder effective navigation and mental mapping. Additionally, these findings provide a deeper understanding of how diverse groups perceive and interact with the city's layout and infrastructure. This analysis is crucial for developing targeted urban design strategies that enhance the overall usability and accessibility of urban spaces for diverse populations.

### 4.1. INTER-PLACE DISTANCE

The functional distance between BUET (BUET pocket gate, Polashi) and Dhaka New Market (Gate no. 2) via Nilkhet Road is approximately 1km as recorded from digital source (Figure 3). From the collected data displayed in Figure 4, it is evident that almost 45% of the Local students and more than 50% of the Migrant students have estimated the cognitive distance to be in between 1 and 1.5km. Although the percentile is slightly higher for the Migrant students, the accuracy of exact inter-place distance judgement is higher among the Local students. 3 out of 20 Local students (15%) and 1 out of 15 Migrant students (6.67%) have exactly mentioned the distance to be 1km.

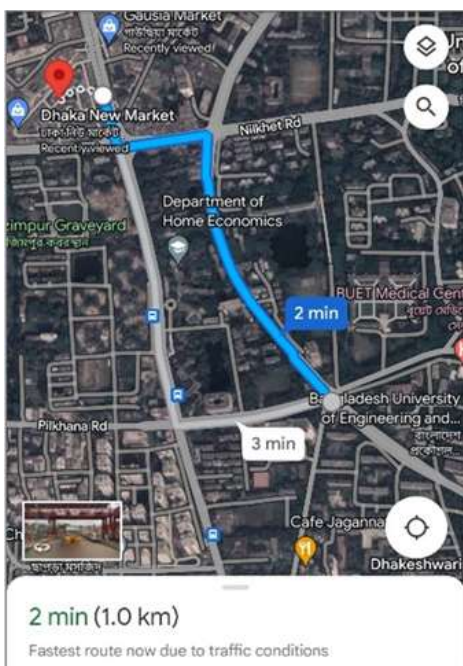


Figure 3, Functional distance between BUET and Dhaka New Market.

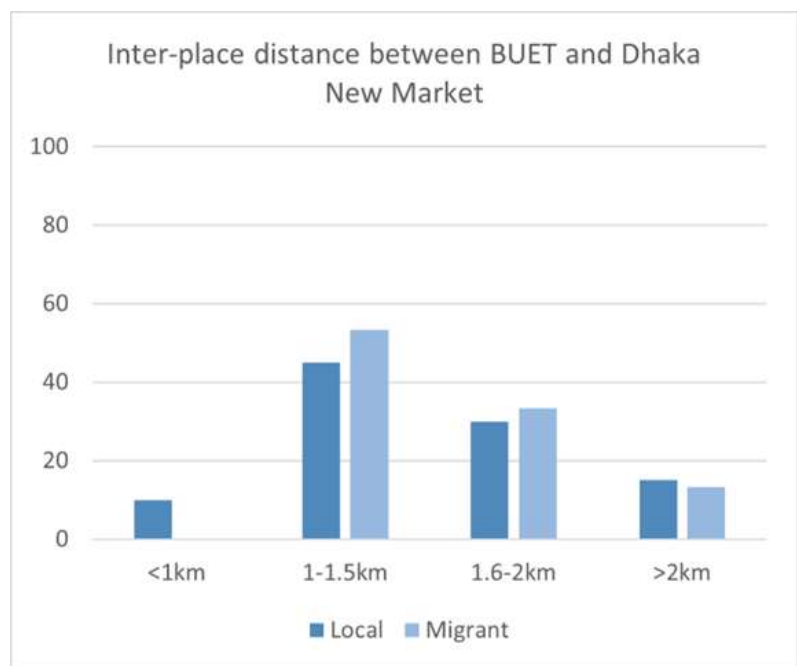


Figure 4, Inter-place Distance identified by Participants

#### 4.2. SCALED POSITION PLOTTING

Participants have been asked to plot the position of Dhaka New Market with respect to BUET campus according to their spatial cognitive ability in a scaled graph where the position of BUET campus has been fixed at (0,0) co-ordinate. According to the collected data, it is evident that the local students' identified co-ordinates (Figure 5) are more intensified within the 1 km radius (marked as dotted circle) of the actual position whereas the migrants' co-ordinates are less saturated within the marked area (Figure 6). Almost 45% of the Local students identified the place within the proximity of the actual position. Hence, the findings from the cognitive distance and the scaled positioning coincide with each other in case of Local students, as evident in the former section.

In case of Migrant students, only 20% of the participants plotted the points within proximity. While half of the participants correctly perceived the inter-place distance, they struggled to accurately translate these mental distances with directional accuracy on paper.

Another observation is evident from these graphs is that in both cases, the percentage of male students identifying the position with better accuracy is higher than that of their fellow female classmates. In fact, the Migrant female participants' identification of the position is evidently more distributed than the other three sub-groups (Local-male, Local-female & Migrant-male).

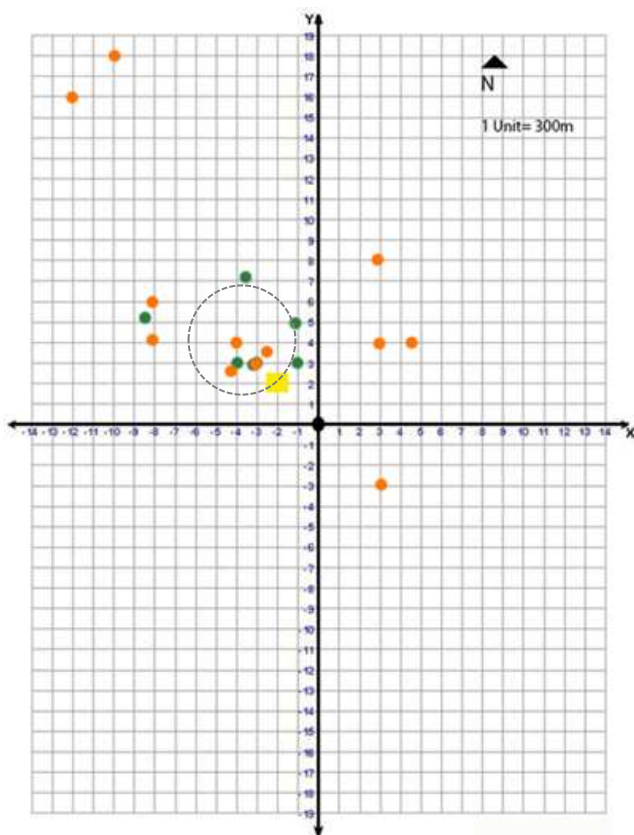


Figure 5, Co-ordinates plotted by Local Students

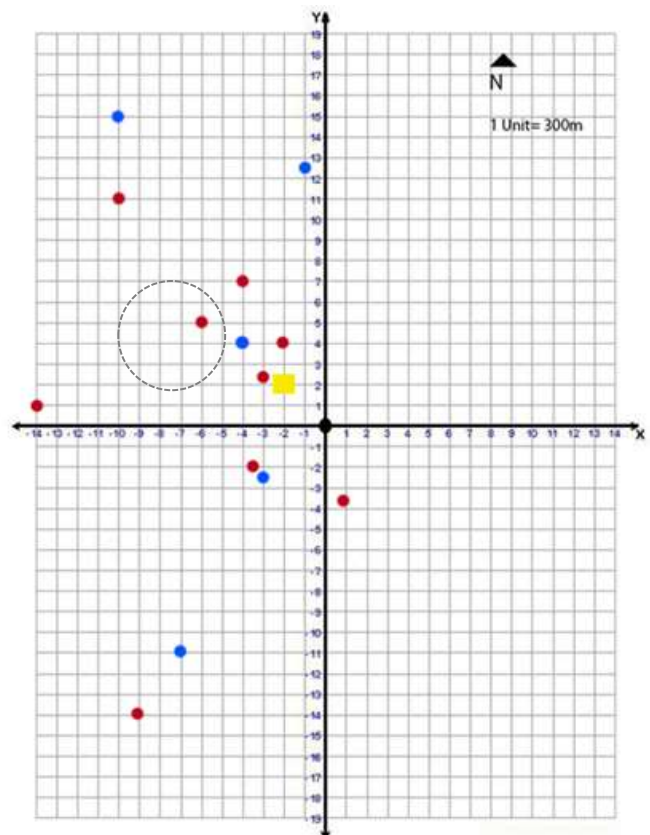


Figure 6, Co-ordinates plotted by Migrant Students

#### 4.3. SKETCH MAP

Participants have been instructed to draw sketch maps of the route, highlighting spatial elements they consider important to navigate through the route. From these maps, 24 elements were recorded, with 50% being Landmarks, 25% Districts, 20.8% Node, and only 4.2% Edges (Table 2). Among them, "Nilkhet Market" (district) has been frequently noted by both Local (65%) and Migrant (86.6%) participants and was denoted as *Nilkhet Book market*, *Nilkhet Printing Shops*, and *Nilkhet Bedding Shops* in their responses. Evidently, the percentile is higher among the Migrants in both questionnaire survey and sketch map. Additionally, sidewalks (edge) along the market have not been acknowledged by the Migrant participants but have minimal impact on Locals, with only 10% mentioning them in their sketch maps. The second-most identified elements by the Local participants (50%) are "Polashi Market Building" and "Mukti o Gonotonro Toron", both are considered as Landmarks. In contrast, nearly 73% of the Migrant participants identified the node of "Nilkhet Filling Station", while only one-fourth of the Local students considered it significant for cognition. Additionally, "Polashi More" (node) has also been acknowledged as a significant element by the Migrants with 46.6% annotating it in their maps.

Table 2: Distribution of Local and Migrant students based on their identification of physical elements in questionnaire and sketch map

Physical Elements	Typology	Local				Migrant			
		From Questionnaire		From Sketch Map		From Questionnaire		From Sketch Map	
		No.	%	No.	%	No.	%	No.	%
Nilkhet (Print /Book/ Bedding) market	District	8	40	13	65	8	53	13	86.6
Nilkhet Sidewalk	Edge	1	5	2	10	-	-	-	-
Polashi More	Node	5	25	6	30	3	20	7	46.6
Nilkhet More	Node	2	10	5	25	4	26.7	3	20
Nilkhet-Mirpur Rd Intersection	Node	3	15	1	5	1	6.7	1	6.7
Nilkhet Filling station	Node	5	25	5	25	6	40	11	73
Polashi Market Building	Landmark	5	25	10	50	5	33.3	5	33.3
Polashi Fire Service	Landmark	-	-	1	5	-	-	-	-
Gausul Azom Market	District	-	-	1	5	-	-	-	-
Dhaka New Super Market	District	-	-	-	-	-	-	1	6.7
ECE Building BUET	Landmark	-	-	1	5	1	6.7	3	20
Eden College Compound	District	-	-	1	5	-	-	3	20
BTCL Quarter	District	1	5	-	-	-	-	-	-
Nilkhet school	Landmark	1	5	1	5	-	-	-	-
Police station, Nilkhet	Landmark	-	-	1	5	-	-	1	6.7
Nilkhet Residential Area	District	-	-	-	-	1	6.7	1	6.7
Salimullah Hall, Dhaka University	Landmark	-	-	1	5	-	-	2	13.3
Dhakeswari Temple	Landmark	-	-	1	5	-	-	-	-
Mukti o Gonontontro Toron	Landmark	9	45	10	50	5	33	6	40
Nilkhet Police Box	Node	-	-	-	-	1	6.7	1	6.7
Foot over Bridge beside New Market Gate	Landmark	2	10	-	-	1	6.7	-	-
Restaurants/ Food Shops	Landmark	2	10	2	10	1	6.7	-	-
Chandrima Market billboard	Landmark	2	10	1	5	-	-	-	-
High walls of New Market	Landmark	-	-	-	-	1	6.7	-	-

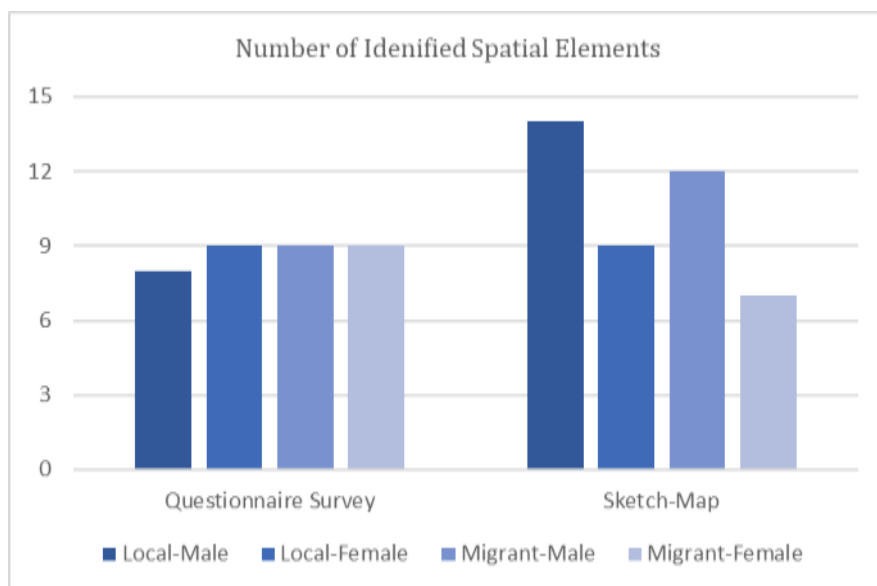


Figure 7, Number of elements identified by different sub-groups

Although the number of spatial elements recorded from the questionnaire survey is nearly the same for each sub-group (Local-Male, Local-Female, Migrant-Male, Migrant-Female), ranging from 8 to 9 elements, the sketch maps reveal a different scenario (Figure 7). To explain in detail, the number of recorded elements from the sketch maps of male participants is higher than those of female participants. The Local-Male subgroup recorded the maximum number of elements, while the minimum number belongs to the Migrant-Female subgroup. To elaborate the findings from the previous paragraph based on male-female ratio (Table 3), the percentage of female Migrants identifying “Nilkhet Market” (district) as a wayfinding element is higher than that of their male counterparts as all female Migrants mentioned it in their sketches. A similar pattern is observed for “Nilkhet Filling Station,” (node) although the scenario is reversed for Local participants. For “Polashi Market Building” and “Mukti o Gonotontro Toron,” female participants overall identified these landmarks more frequently as points of reference than the male respondents. Furthermore, most of the male respondents drew their maps (Figure 8a, 8b) on a broader scale, incorporating nearby elements such as *Eden College (district)*, *ECE Building BUET (landmark)*, *Salimullah Hall Dhaka University (landmark)*, *Dhakeswari Temple (landmark)*, *Polashi Fire Service (landmark)*, and *Dhaka New Super Market (district)*. In contrast, the female respondents’ maps (Figure 8c, 8d) focused solely on the elements directly related to the route, excluding surrounding details. They provided specific features of the route, such as food shops like Burger King and certain billboards as reference points for navigation.

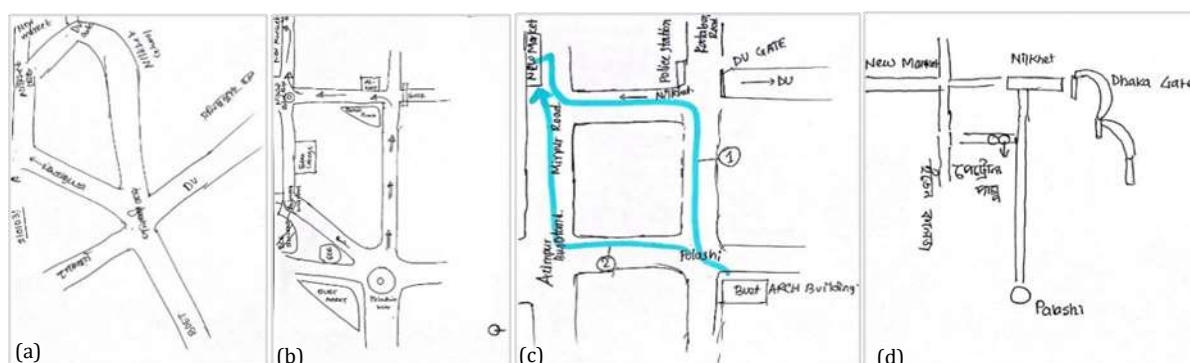


Figure 8, Sketch-map by participants (from left: a, Local-male; b, Migrant-male; c, Local-female; d, Migrant-female)

Table 3: Percentage of Male and Female students based on their identification of physical elements in questionnaire and sketch map

Physical Elements	Typology	Local				Migrant			
		From Questionnaire		From Sketch Map		From Questionnaire		From Sketch Map	
		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
Nilkhet (Print /Book/ Bedding) market	District	14.3	53.8	71.4	61.5	60	40	80	100
Nilkhet Sidewalk	Edge	14.3	-	-	15.4	-	-	-	-
Polashi More	Node	14.3	30.8	14.3	38.5	20	20	50	40
Nilkhet More	Node	-	15.4	14.3	30.8	10	60	20	20
Nilkhet-Mirpur Rd Intersection	Node	28.6	7.7	14.3	-	-	20	10	-
Nilkhet Filling station	Node	42.9	15.4	42.9	15.4	40	40	60	100
Polashi Market Building	Landmark	42.9	15.4	42.9	53.8	40	20	30	40
Polashi Fire Service	Landmark	-	-	14.3	-	-	-	-	-
Gausul Azom Market	District	-	-	14.3	7.7	-	-	-	-
Dhaka New Super Market	District	-	-	-	-	-	-	10	-
ECE Building BUET	Landmark	-	-	14.3	-	10	-	30	-
Eden College Compound	District	-	-	14.3	-	-	-	20	20
BTCL Quarter	District	-	7.7	-	-	-	-	-	-
Nilkhet school	Landmark	14.3	-	14.3	-	-	-	-	-
Police station, Nilkhet	Landmark	-	-	14.3	7.7	-	-	-	20

Nilkhet Residential Area	District	-	-	-	-	10	-	10	-
Salimullah Hall, Dhaka University	Landmark	-	-	14.3	-	-	-	20	-
Dhakeswari Temple	Landmark	-	-	14.3	-	-	-	-	-
Mukti o Gonotontro Toron	Landmark	71.4	30.8	42.9	53.8	30	40	40	40
Nilkhet Police Box	Node	-	-	-	-	10	-	10	-
Foot over Bridge beside New Market Gate	Landmark	28.6	-	-	-	-	20	-	-
Restaurants/ Food Shops	Landmark	-	15.4	-	15.4	-	20	-	-
Chandrima Market billboard	Landmark	14.3	7.7	-	7.7	-	-	-	-
High walls of New Market	Landmark	-	-	-	-	-	20	-	-

Apart from the findings stated under previous subsections, another dimension has been unveiled through questionnaire survey. Questions regarding the frequency of usage of digital wayfinding tools by the participants gives a subtle indication of our current urban experience and social practices embedded in our day-to-day life. Migrants were more dependent on mobile phone based GPS navigations (Google map, apple map) as almost 67% of them followed google map when they first visited New Market whereas, only 35% of the local students used it. Female respondents are more dependent on GPS navigation, be it local or migrant, as 80% of the migrants and 38% of the locals used it whereas the ratio is 60% and 28% for migrant male and local male students respectively. 20% of the female respondents did not feel the necessity of using digital supports as they travelled with their parents or friends whereas, the male participants tried to gather information mostly through exploration, took help from passers-by, rickshaw pullers and other vehicle drivers or had been accompanied by their peers.

### 5. Discussion

Based on the comprehensive analysis detailed in the preceding section, several key observations emerge:

The percentile of accurate inter-place distance estimation between the BUET campus (BUET pocket gate, Polashi) and Dhaka New Market (Gate no. 02) is nearly identical for Local (45%) and Migrant (50%) students, with over half of the participants failing to make accurate judgements. This discrepancy may be attributed to our socio-cultural practices, as many children are accompanied by their parents while going out, which the questionnaire data supports; nearly 67% of them reported being accompanied by their parents until the age of 20, limiting their spatial cognitive development (Figure 9). It underscores the importance of clear navigational cues at urban scale to help all users, especially newcomers, navigate cities with confidence. Additionally, around 10% of Local participants perceived the cognitive distance shorter than it actually is, likely due to prior familiarity with the destination and habitual movement, which has resulted in a sense of increased proximity.

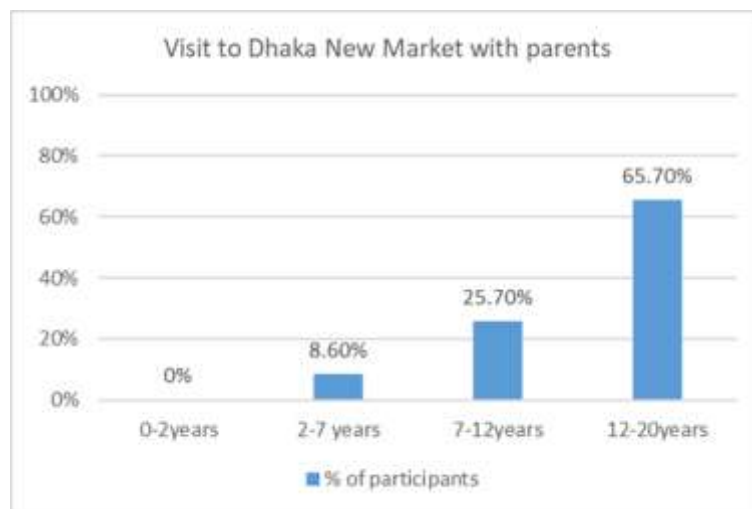


Figure 9, Percentage of participants accompanied by parents during visit to New Market

When the mental cognition distances were plotted on two-dimensional graph paper, it was found that Local participants plotted the coordinates with greater accuracy than Migrants. This difference can be attributed to the Local students' increased familiarity with the space. Most of them had better exposure to the destination because of growing up in the neighbourhood or being engaged in frequent shopping encounters since childhood. Thus, a higher percentage of Local



students accurately identified functional distances in their inter-place distance judgments, while Migrants, being less familiar with the setting, plotted more dispersed coordinates in their graphs compared to their Local counterparts.

In case of recognising spatial references for wayfinding, both Local and Migrant students frequently mentioned district like, “Nilkhet Market”. The percentage is higher for Migrant students, as they reside in residential halls and often visit this area to meet their necessities. While most of the Local participants considered landmarks like, “Polashi Market Building” and “Mukti o Gonotontro Toron” as points of reference, Migrants more frequently preferred nodes like “Polashi More” and “Nilkhet Filling Station” for wayfinding, as evident from their cognitive maps. However, none of the participants annotated paths in their cognitive maps although they subconsciously drew sequential maps. Male participants, both Local and Migrant, included elements in their maps from the surroundings and linked their route to broader setting. In contrast, female participants focused only on elements along the route, reflecting fragmentary thought process. Female Migrants, in particular, performed poorly in both scaled position plotting and sketch mapping. This scenario can be attributed to cultural practice where females have less outdoor exposure and restricted activity space, leading to poorer cognitive development. However, the percentage of female participants identifying commonly encountered elements along the route is higher than the male ones, indicating their detailed attention to specific routes.

Overall, the discussion highlights the essential role of urban design in fostering spatial awareness and cognitive development through place-based learning. The differences in mental mapping between local and migrant students, along with gender-based differences in wayfinding strategies, highlighted the impact of socio-cultural practices on spatial cognition and awareness. Local students, with greater exposure to familiar environments, demonstrated more accurate spatial mapping, while migrant students mostly relied on distinctive nodes due to their lesser familiarity. The reliance on GPS based navigation tools among migrants further highlights a gap in creating a legible urban environment. As evidenced by literature, although these tools make movement easier and provide a sense of security, they also diminish our natural navigation abilities by encouraging step-by-step, guided routes, limiting a newcomer’s overall experience of the city (Sönmez & Önder, 2019). In another study by May et al. (2003) indicate that GPS navigation does not completely inhibit the perception of urban elements; users still check to ensure that the device aligns with their surroundings. Thus, variations in cognitive mapping illustrates the need for urban design guidelines that cater to diverse backgrounds, promoting inclusivity through recognizable landmarks, intuitive pathways, and supportive navigation aids. By enhancing familiarity and accessibility through strategic placemaking, urban environments can improve spatial cognition for all residents, fostering a more inclusive and connected city fabric.

## 6. Conclusion

The study reveals important insights into how urban design elements affect spatial cognition among local and migrant students, emphasizing the impact of sociocultural backgrounds, familiarity, and need-based spatial usage on their navigation experiences. Gender-based differences show that males tend to navigate through broader route associations while females concentrate on specific elements, possibly due to societal restrictions on outdoor exposure. Such variations in cognitive mapping underscore the importance of designing spaces that accommodate different navigation and spatial needs. Given the rise in urban migrant populations, it is essential for urban designers to incorporate migrants’ perspectives in spatial layouts, making mobility within cities easier and safer for all. In fact, it necessitates the need to look beyond Lynch’s “five elements” framework and derive culturally practiced navigational aids as socio-cultural practices impact our cognitive ability to a great extent.

The study highlights the benefits of cluster-based urban development with identifiable characteristics and with spatial arrangements tailored to the cognitive needs of specific groups. As female participants often focused on route-specific details during navigation, additional support—such as marked spatial links—may enhance movement and safety, particularly for migrants or individuals unfamiliar with the area. Urban design guidelines need to be developed by addressing these cognitive differences, to create more inclusive and human-centered spaces allowing people from all backgrounds to move confidently through urban spaces.

Although the study did not focus on the use of digital maps, the findings highlighted the potential of integrating digital navigation tools like GPS-enabled apps, which offer increased security, particularly for women. However, these tools may hinder natural cognitive development and it requires careful investigation in order to understand their impact before deriving guidelines. Expanding the participant group beyond a single technical institution could offer broader insights, as spatial cognition varies across different backgrounds. However, with a specific participant group, these initial findings lay the groundwork for understanding dynamics of cognitive differences in urban environments, guiding the designers toward fostering inclusive, accessible, and well-navigated urban spaces.

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