Influential Factors on Children's Spatial Knowledge and Mobility in Home-School Travel
A Case Study in the City of Tehran

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Abstract
This paper studies two main issues: 1) the parameters forming children's spatial knowledge and 2) the influential factors on children's mobility in home-school travel and the choice of travel mode. For this purpose the daily home-school itinerary of children living in a high density residential community within Tehran was surveyed. The data were analyzed with relevance to age, gender, travel mode, home-school distance, traffic and social safety. Results confirmed the significance of children's mobility within home-school travel in their acquisition of spatial knowledge. Those children who walked to school or took the bus on their own, presented better sketch maps compared to those who were driven by car or took the school bus. Age was also found to be a significant factor in the children's mobility within home-school travel and in the drawing of the sketch maps. Unexpectedly, boys did not present a better spatial knowledge than that of girls. This may be attributed to the higher average home-school distance for boys. Finally, the results indicated that traffic danger and social insecurity are indirectly influential on children's spatial knowledge by imposing restrictions on their mobility within home-school travel.

Keywords: home-school travel; spatial knowledge; sketch map assessment; travel mode; Tehran

1. Introduction
1.1 Background and Problem Definition
One of the key aspects of a child-friendly city is the provision for sustainable modes of transport: walking, cycling and public transport (Tranter, 1995). In this regard, the school journey is a key area where changes in travel behaviour can produce real benefits for children, their parents (economical costs and spent time), and the environment. Research shows that in many countries, traffic jams connected to the school journey have created serious problems (Sustrans, 2002; Bradshaw, 1999). For instance, driving children to school contributes to air pollution at a greater rate than longer urban trips (Tranter, 2000).

In the city of Tehran, like many other metropolitan areas, there has been an increasing trend towards vehicular modes for home-school travel, and the school journey by car has become a significant feature of daily life for many families. Meanwhile the city suffers from an air pollution crisis, traffic congestion, and most of its districts are involved in the maldistribution of schools1. School journeys account for approximately 20% of morning rush hour traffic (Hamshahri Newspaper, 2006; Tabatabaei, 2001). At the same time the desire of parents to protect their children by driving them to school has caused other health and safety problems, such as increased air pollution from car emissions and greater traffic congestion around the schools, which in turn results in fewer children developing an autonomy. In addition, the increasing parental fear of danger from strangers and assault is placing even more restrictions on children's mobility.

It is argued that a decline in children's independent mobility can as a whole be seen as a constraint on pro-environmental travel mode choices (Johansson, 2002). Furthermore, a long and continuous period of accompaniment in home-school itinerary may delay the acquisition of spatial skills, environmental knowledge, and development of the child's independence (Hillman, 1990). Children who are driven to school are less likely to develop essential road sense, which can only be learnt by walking and cycling (Tranter, 1995). Opposing these arguments, other research shows that spatial skills are not influenced by the mode of school travel and children accompanied or driven by their parents have almost the same environmental knowledge as those who have more autonomy in their school journey (Joshi, 1999).

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parents’ fear of both traffic and danger from strangers in public spaces is the focus of much research (Kytta, 2004; Sustrans, 2002; Tranter, 1995; Hillman, 1990).

According to Piaget, Hall and White there are three developmental stages in the acquisition of spatial knowledge by children as they grow up: 1) landmark knowledge, 2) route knowledge, and 3) survey knowledge (Montello, 1998). Research shows that the development of route and survey knowledge depends on the level of the individual's interaction with the environment and the quality of the individual's movement. Survey knowledge can be acquired by individual-environment interaction, and plays an important role in constructing a cognitive map of the surrounding environment. The process of constructing a cognitive map strongly depends on the goal of the subject's actions and movements. Children's environmental knowledge is presumed to be an active problem solving process in so far as it is a significant tool for achieving practical objectives in the course of their daily actions. In this regard children's movement goals and their travel plans are considered to be important controlling factors in the construction of cognitive maps as it is believed that environmental knowledge is acquired in association with their formation (Rissotto, 2002).

1.2 Research Objectives

Based on the above stated theoretical background, this paper studies two main issues: 1) the parameters forming children’s spatial knowledge and 2) the influential factors on children's mobility in home-school travel and the choice of travel mode.

For the first issue, the paper focuses on the children's ability to recall and represent their home-school itinerary (Section 3). Then, to acquire a deeper understanding of the influential factors on children's spatial knowledge, the authors studied the factors affecting the choice of travel mode and the children's degree of independent mobility within the daily school journey as the secondary influential factors on children's spatial knowledge (Section 4).

2. Research Design and Methodology

2.1 Selected District

This paper presents a case study of a typical housing development (Ekbatan town) in the city of Tehran. This high density residential community at the western entrance of Tehran has been planned and constructed in three phases since 1974 and is still under construction. Ekbatan has been acting as a prototype of modern apartment-lifestyle living for other suburban residential developments. Fig.1 shows the location of Tehran and Ekbatan.

Ekbatan consists of three different zones of semi high-rise prefabricated concrete block apartment buildings. The town is surrounded by expressways with each of its three zones being a home-zone where car traffic has been limited. Ekbatan is a large self-sufficient residential area with a total area of 1,700,000 square meters, which includes schools (18), nursery schools (17), shopping malls, sports clubs and play areas, rest areas, and its rich green spaces (Table 1.). Many of the residents claim that they rarely leave the town for their daily needs. The town is situated in an urban zone with a remarkably higher than average ratio in school bus usage: 17.7% of school journeys are made by school bus in the urban zone 5, while the average in Tehran is 12.4% (Tabatabaee, 2001).

![Fig.1. Map of Ekbatan, Tehran, and Iran](image_url)

Table 1. Facts and Features of Ekbatan (*: Estimation)

| Zone 1 | Zone 2 | Zone 3 | All  |
|--------|--------|--------|------|
| Area (m²) | 875,000 | 600,000 | 225,000 | 1,700,000 |
| Population* | 18,000 | 22,600 | 6,600 | 47,200 |
| Number of Blocks | 10 | 17 | 4 | 31 |
| Number of Flats | 5,619 | 2,068 | 2,068 | 14,755 |
| Flats per Entrance (average) | 36 | 126 | 36 | 54 |
| Block Entrances (average) | 15.7 | 3.3 | 14.5 | 8.1 |
| Number of Floors | 5, 9, or 12 | 12 | 5, 9, or 12 | 5, 9, or 12 |
| Elementary School | (1G, 1B) | (1G, 1B) | (1G, 2B) | (3G, 4B) |
| Junior High School | (1G, 1B) | (1G, 1B) | (2G, 1B) | (4G, 3B) |
| Student Numbers* | 1,600 | 1,600 | 2,400 | 5,600 |

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2.2 Subjects

Previous research shows that gender and age are influential factors in children's spatial knowledge. Thus, in the first survey of this study, the subjects consisted of 38 girls and 37 boys from 4 different schools in 3 age groups of 9, 11, and 13 year olds (see Table 2). The subjects were chosen from both elementary and junior high schools in order to observe the age-related effects on independent mobility and spatial knowledge more clearly. For each age-gender group all students in a class were requested to voluntarily participate in the survey.

Table 2. Sample Size and Distribution (First Survey)

| Grade Group       | Boys | Girls | Total |
|-------------------|------|-------|-------|
| 3rd Graders (9 y) | 12   | 15    | 27    |
| 5th Graders (11 y)| 12   | 16    | 28    |
| 7th Graders (13 y)| 12   | 15    | 27    |
| Total             | 36   | 46    | 82    |

Table 3. Sample Size and Distribution (Second Survey)

| Grade Group       | Boys | Girls | Total |
|-------------------|------|-------|-------|
| 3rd Graders (9 y) | 0    | 6     | 6     |
| 5th Graders (11 y)| 7    | 15    | 22    |
| 7th Graders (13 y)| 11   | 22    | 33    |
| Total             | 28   | 43    | 71    |

2.3 Procedures

This study consisted of two field surveys conducted in January 2004 and May 2006. The first field survey involved a questionnaire, which targeted the interrelationships between the subjects' spatial knowledge and their age, gender, and mode of home-school travel. Two researchers distributed the questionnaires to each age-gender group of students in their classrooms with the assistance of their class teacher during two class sessions. On the first day the children were asked to draw a sketch of their route from home to school. To do this, their school's position in relation to the boundaries of the study area was shown on a blank sheet. They then placed their home, drew their daily home-school path, and finally added any landmarks and 'things' which were of importance in their view. The following day the children marked the position of their home and showed the home-school route on a blank map of the district. The subjects' parents were asked to complete the same tasks to evaluate whether the home-school route drawn by each student was correct. A feedback of 75 (71%) from the 106 distributed questionnaires was received. One of the authors scored all of the sketch maps twice, and then considered the average of the results from two sessions as the final score. The results are discussed in section 3.

In the second field survey, a series of semi-structured interviews with 32 children and their parents was conducted in regard to their activities within their daily home-school travel and their demanded independent mobility for this. The subjects were selected from amongst those who had participated in the first survey based on their willingness to participate further in the research (see Table 3.). Interviews consisted of questions about the children's current and preferred home-school travel modes and their experience of fear when they have been out alone. They were also interviewed about what could encourage them to walk, cycle, or take a bus from home to school and back. The interviews took place during the after-school hours in the entrance lobby of each subject's apartment building block. Giving consideration to previous studies (Ahmadi, 2004; Hart, 1979), for the comfort of the subjects, a female research assistant accompanied the male researcher for interviewing the girls. During the interviews with the subjects' parents, the parents included their concerns regarding traffic, danger from strangers and the impact of these factors on choosing the mode of their children's school journey. The parents were also asked about the level of freedom they give to their child. The results were applied to the discussion on section 4. Table 4. presents a summary of the survey's contents.

Table 4. Survey's Content

First Survey – January 2004

| Questionnaire Survey          | 1. Personal profile: Age, gender, family members |
| 2. School Journey: Travel mode, time, distance, stops on the way home |
| 3. Freedom of movement for activities other than the school journey |
| 4. The drawing of a sketch map of the home-school itinerary |
| 5. The drawing of the home-school itinerary on a blank map of the district |

Second Survey – May 2006

| Children's Interview           | 1. Current/preferred travel mode |
| 2. Diary of a school day focusing on activities during home-school travel |

| Parents' Interview             | 1. Current/preferred travel mode |
| 2. Concerns over traffic and danger from strangers |

2.4 Method of Analysis

2.4.1 Measurement of Spatial Knowledge

Acknowledging the emphasis of various researchers on the importance of using different techniques to investigate children's spatial knowledge, in this study the authors used two measurement techniques: 1) the drawing of a sketch map, and 2) The use of a blank map.

2.4.1.1. The Drawing of a Sketch Map

The differences in drawing style and the level of drawing skill brought a wide variety of sketches, which were difficult and challenging to analyze. Subjective methods (such as that of Lynch, 1960) of analysis of the sketch map were not preferred due to their dependence on the assessor and sessions of assessment. Objective analysis methods such as bi-dimensional regression, orientation-structure assessment (Rissotto, 2002), and syntactic analysis were also considered. The authors concluded that Rissotto's assessment method was the most appropriate given the scale of the study area and drawing style of the majority of the collected sketch maps, which placed considerable emphasis on the home-school route. This method also puts sufficient stress on landmark knowledge. According to this method, to assess each sketch map, the following parameters were taken into account: orientation, structure of the route, and details.

2.4.1.2. The Use of a Blank Map

The home-school itinerary drawn on the blank map was assessed in the same way as the sketch maps.
with consideration given to the two parameters of orientation and structure. In addition, the distance between the represented home's position and its actual position was measured in centimetres on the blank map as an indicator for distortion in placement. Fig.2. shows an example of the scoring assessment given to both a subject's sketch and blank map.

2.4.2 Mobility in Home-School Travel

Statistical analyses were applied to evaluate the possible interrelationships amongst the variables of home-school distance, travel time, stops on the way home, age, gender, and mode of travel. Also, both the parents and children's concerns over traffic, danger from strangers, and their preferred mode of travel were extracted from the interviews and discussed.

3. Influential Factors on Spatial Knowledge

3.1 Age and Gender Related Findings

A breakdown of the results by age group (see Fig.3.) indicates that there is an increase in the sketch map total scores that relates to the increase in age of the subjects (F=3.39, df=2, p=0.042). However, in neither the orientation band nor in the details was any significant score increase by age observed. Only the structure band increased significantly as age increased (F=4.61, df=2, p=0.014). A gender based t-test regarding the total points scored on the sketch maps revealed that there is no significant difference between boys and girls (t=1.02, df=49, p=0.118). The results showed that the ability of showing the itinerary on a blank map is significantly related to age (F=6.46, df=2, p=0.003) however, no significant difference between boys and girls was observed (t=0.39, df=49, p=0.349).

Distortion in locating the subjects' home on the blank map showed a relatively significant decrease as age increased (F=3.65, df=2, p=0.033) but it was not found to be gender-related (t=0.16, df=49, p=0.437).

The gender-related results of this study counter the findings of previous research, which indicated that boys represent their local environment better than girls. This may reasonably be explained by the fact that in this study the average home-school distance for boys was more than that of girls (944 meters vs. 588 meters). This results in an increased use of driven travel modes, which in turn may have equalized the less representative abilities of girls.

3.2 Travel Mode Related Findings

Home-school travel modes were classified into five groups. Whenever the travel mode of home-to-school was different from that of school-to-home, the travel mode of school-to-home was taken into account (17% of the sample). The reasoning is that the morning rush decreases the differences between the travel modes in terms of the level of freedom and opportunities they provide for surveying the local environment. Hereafter, in this paper, the authors will use the following abbreviations for travel modes: FA (on Foot Alone), FP (on Foot with Parents), PT (Public Transport), SB (School Bus), and PC (Parent's Car). Table 5. shows the distribution of the sample by travel modes.

Data analysis by travel modes (see Fig.4.) showed that there were significant differences in the representation of both orientation and structure bands of the sketch maps (F= 3.51, df=4, p=0.014 for orientation and F=3.66, df=4, p=0.011 for structure). However, no significant difference in the representation
of details was found (F=0.36, df=4, p=0.836). This is supported by previous research (Rissotto, 2002).

In addition, no significant difference was observed between travel modes in relation to the drawing of the travel route on the blank map or distortion in locating the subjects' home on the blank map (F=1.10, df=4, p=0.367 for the drawing of the travel route, and F=1.47, df=4, p=0.226 for the distortion in locating of the subjects' home).

The sketch map scores shown in Fig.4. show that FP travellers proved to have the best spatial knowledge from amongst the five different modes of travel. Also a significant difference was found between FP and PC travellers (Tukey test for FP/PC: p<0.05). On this point, the results differ from Rissotto's findings (2002). However, no significant difference in spatial knowledge was found between FP and FA travellers. This partially confirms the findings of Joshi (1999).

After FP travellers, those children who travelled on their own (FA or PT) showed better results than others who travelled by SB or PC. This finding confirms the results of previous research (Rissotto, 2002) that children with greater independent mobility have better spatial knowledge. The less spatial knowledge of those travelling by SB or PC can also be attributed to distracting conversations and activities participated in whilst travelling by SB or PC. The above interpretations are illustrated in Fig.5.

Another breakdown of the results into vehicular and walking modes (see Table 6.) revealed that those children who walked (FA or FP) have shown a significantly better representation of the sketch map than those who used vehicular modes (SB, PC, and PT). This is supported by previous research (Tranter, 1995; Rissotto, 2002). However, no significant difference between travel modes was observed for the blank maps point.

3.3 Correlation of Different Measurements

Table 7. shows the level of correlation between the results of the two measurements applied in this study: The drawing of a sketch map and the reading of a blank map. The table indicates that:

There is a linear relation between the orientation and structural bands of the sketch maps (r = 0.58). There is also a negative linear relationship between the distortion of home placement and showing the itinerary on the blank maps (r = -0.50). The distortion of the home placement on the blank maps is negatively correlated with the orientation band of the sketch maps (r = -0.44). The results of showing the itinerary on the blank map have some linear relationship with those of the structural band (r = 0.38). It can be seen that the resulting analysis of the blank maps bands does not fully support those of the sketch map. The table indicates that the detail band has hardly any linear relation with other band results (|r| < 0.3). According to the findings it can be assumed that the use of a blank map reduces the possibility for representation of existing differences in the cognitive map of various children. The author's findings also support the previously mentioned argument emphasizing the importance of using different techniques to investigate children's spatial knowledge.

4. Influential Factors on Mobility in Home-School Travel

The children's independent mobility within home-school travel was investigated and analyzed with
consideration given to the current and preferred means of travel, stops on the way home and activities during the travel time.

4.1 Age and Gender Related Findings

The distribution of subjects in regard to travel mode indicated that choice of travel mode was significantly related to both factors of age and gender (Chi-square for age=21.16, df=8, p=0.007; and Chi-square for gender=11.88, df=4, p=0.018). Fig. 6. illustrates the frequency of various travel modes by age and gender. It shows that the number of accompanied or driven children to school (FP, PC, and SB) decreases as age increases. PT mode is more frequent among 13-year-olds.

The results also show that girls are less often accompanied or driven than boys. This may be attributed to the relatively superior educational facilities of the surveyed boys’ school, which as a result attracts more male students from further away (The average home-school distance being 944 meters for boys and 588 meters for girls). Also, those parents who send their children to a superior school are typically more concerned about the safety of their child during the home-school travel.

4.2 Home-School Distance

The results showed that there was a significant relationship between school-home distance and the choice of travel mode (F=31.34, df=4, p<0.0001). However, the results of the Tukey test revealed that there was no significant difference either between FA and FP or among PT, PC, and SB. The average home-school distance for walking modes (FA, FP) was 349 meters and for vehicular modes (PT, PC, and SB) 1,324 meters. The t-test showed a significant relationship between home-school distance and the choice of walking or vehicular modes of travel (t=10.83, df=49, p<0.0001).

4.3 Travel Time and Stops on the Way Home

Travel times to and from school were measured separately. Table 8. shows the average home-school travel time as well as the difference between school-to-home and home-to-school travel time (Δ) by travel mode. No significant differences were observed either between various age groups (F=0.68, df=2, p=0.505) or between boys and girls (t=0.68, df=87, p=0.249). However, average travel time was significantly related to travel mode (F=8.25, df=4, p<0.0001). Tukey test results indicated that there was no significant difference between the time of various vehicular modes (PT, PC, and SB). Only between FP and PT was ‘Δ’ significantly different (p<0.05).

Table 9. shows the results concerning the frequency of children’s stops on the way home. Having a stop on the way home was significantly related to age (X²= 8.64, df=2, p=0.013) but not to gender (X²= 2.64, df=1, p=0.104). It also had a significant relationship to the travel mode (X²= 14.71, df=4, p=0.005).

Unexpectedly, FP or PC travellers had more stops from school to home than the other children. In this, the author's results disagreed with Rissotto (2002) that accompanied children are not given the opportunity to pursue their own interests. Malihe, an 11-year-old girl accompanied by her mother on foot (G11FP) says: "On the way back home, I usually buy an ice-cream from the supermarket." Her mother adds: "And usually we have a brief stop at the green area next to our block...it's even good for me because I can meet some of the other mothers there and enjoy talking with them while Malihe is playing." Their statements in conjunction with this study's quantitative results reveal that travelling accompanied by parents (FP or PC) is not necessarily — as Rissotto claims — a move as fast as possible between school and home. On the contrary, it supported previous findings that walking to and from school improves parents' social interactions in the neighbourhood (Travelwise, 2002).

During the interviews the 28 parents expressed their anxieties, which included traffic danger and social insecurity. This suggested to us that there is a higher level of concern with regard to social insecurity than traffic danger in the studied district. The interview results also confirmed Sustrans' findings that children are generally aware of their parents concerns and often take on some of the burden of concern in not wanting to worry parents unduly and as Hillman (1993) argues, not only do they have a limited independent mobility, but are also afraid of their community environment.

Matin (B11FA) for instance says: "I don't stop anywhere. I go back home directly. I even don’t like to stop in the park because it's not safe and there are strangers around... and my Mom and dad get worried too." Or Mohammad (B11FA) says: "After school, I go home directly so that my Mom doesn't get worried and after getting back home, I go to the park or wherever..."
else to play."

4.4 Current vs. Preferred Travel Mode

Thirty-two children and 28 parents were interviewed on why they have chosen their current mode of travel and what travel mode they prefer. It was found that the current travel mode was generally more related to parents’ preferences than children’s (see Fig.7.). However, the boys’ current travel modes were more related to their own preferences rather than those of their parents. It indicates that boys are more persistent in negotiating for their preferred mode of travel. Roughly half of the interviewed children travelled on foot (FA, FP), but 60% of them preferred to do so in order to have more freedom or interaction with their local environment. Many children found walking back home with their friends or even with their parents more social and communicative. For instance, Mahshid (G11PT) who is accompanied by her mother says: "I like walking back home better than taking a bus because I can freely talk about my school events to my mom." Or Ashkan (B13SB) says: "I prefer to walk back home from time to time and to stop off at the game-net club or CD shop." At the same time both Mahyar (B11PC/PT) and his parents prefer the FA travel mode but he says: "There are no kids to walk together with, and I’m kind of afraid of the strange guys who all the time hang around in the street..." and his mother supports him by saying: "... the school is fairly close but if the traffic was less and there were safer walkways and more children to walk with, I would prefer him to walk to school."

Children stated increased social safety, more children to walk with, and less air pollution as three factors that may encourage them to walk to school while the most frequently mentioned factors by parents were social safety, safer places to cross the streets, and less home-school distance (see Table 10.).

As for the real need of a car for the school journey, only one of the parents believed that a car was indeed very necessary, while five parents (16%) preferred to use a car believing it as the safest and most reliable mode. Shervin (B13PC) is driven to school either by his father or in his friend's parent's car, but his mother prefers him to walk. He used to travel by SB until he was 11 and still prefers to be driven as he finds it more comfortable. It confirms Sustrans findings (2002) that there is a strong link between a car-dependent habit established in childhood and its continuity into adulthood. Even though all the boys and 87.5% of the girls who participated in this survey had a bicycle, none of them cycled to school. It was found that 20% of them wanted to do so, but only 8% of parents preferred this mode. The parents cited more cycle lanes, a safe place to leave the bicycle, and less traffic as the three most important factors that may influence them into letting their child cycle to school. In the children's view a safe place to leave their bicycle was more important than cycle lanes. For them the third most encouraging factor was more children to cycle with (see Table 10.).

With the exception of two boys, all the other PT travelling parents were unsatisfied with their travel mode. The most concerning issues were infrequent buses, few children to travel with, and a lack of seat availability. However this mode of travel was still preferred more than SB or PC by children (Table 10.) due to having more freedom and autonomy. Meanwhile parents were concerned about safety during the long distance between home or school and the closest bus stop.

5. Conclusions

The aim of this paper was to examine the influential factors on children's spatial knowledge and their mobility in home-school travel.

It was found that 'age' and 'travel mode' are two influential factors in relation to children's spatial knowledge. In contrast with previous research, no significant difference was observed between boys and girls, which is attributed to a higher than average home-school distance for boys. This revealed that a longer home-school distance either directly or indirectly (by imposing vehicular travel modes) weakens spatial knowledge.

Focusing on travel modes, the authors’ found that walking modes give children the opportunity to explore their environment and know it better. In contrast with previous research, it was observed that the information exchanged between the child and the parent in the case of FP travellers not only offset their lack of autonomy but also provided the children with a better spatial knowledge than that of FA travellers. PT was found to be the best vehicular travel mode in terms of clarity of spatial knowledge due to the self-reliance of the journey and less distracting conversations and activities in the bus, rather than those of SB or PC.
Travel modes in turn, were significantly related to children's age and gender. Also, the home-school distance was a significant factor in choosing between walking or vehicular travel modes. It was also found that having a stop on the way home is significantly related to travel mode and age, but not to gender. It was observed that FP and PC travellers had more stops than other groups, which indicates that school journeys could be considered as an improvement in the parents' social interactions in the neighbourhood.

The results also revealed that parents' concerns over traffic danger and social insecurity were transferred to the children and as a result the children either became afraid of their community environment or took on some of the burden of concern in not wanting to worry their parents. Therefore, even FA travellers had a reduced level of freedom.

Cycling was not encouraged due to the risk of accident and theft, lack of parking space, and for girls restricting traditional norms. Meanwhile children stressed their wish to use their bicycles as a means of travel to school. Many children cited "more children to travel with" as the main factor encouraging them to travel mode and age, but not to gender. It was observed that FP and PC travellers had more stops than other groups, which indicates that school journeys could be considered as an improvement in the parents' social interactions in the neighbourhood.

Finally, the results indicated that traffic danger and social insecurity are indirectly influenced on children's spatial knowledge by affecting their mobility within home-school travel. However, further quantitative studies on the influence of these indirect factors on children's spatial knowledge and their mobility in home-school travel are still needed.

Notes
1. In the city of Tehran, every urban zone (see the upper map in Fig.1.) is divided into smaller districts based on size and population (7 districts in the case of urban zone 5). According to the policies applied by the Ministry of Education, a public school (junior high and especially elementary schools) only admits the students who live within its district. However, in exceptional cases such as the student's high rank or having the background of living in a district, a school may accept a student from outside of its coverage area. This limitation of choice is not applicable to private schools. The reputation and level of a private school determines its own coverage area. The boys' private school in this study, for instance, acts rather locally in comparison with some other famous private schools in the other urban zones, due to its middle class standards and its location in the special context of Ekbatan district.
2. Cognitive maps are a type of mental processing composed of a series of psychological transformations by which an individual can acquire, code, store, recall, and decode information about the relative locations and attributes of phenomena in his everyday spatial environment. Cognitive maps may also be represented and assessed on a paper through various practical methods such as a sketch map or any variety of spatial representation.
3. This is the number of elementary, junior high, and senior high schools in zones 1, 2, and 3, and not the south-eastern area.
4. The source of the map of Tehran is Atlas of Tehran Metropolis (Habibi and Hourcade, 2005). The map for the chosen district has been re-drawn by the authors based on the GIS maps at Tehran GIS center. The authors have also updated the map of Ekbatan based on a field observation in 2006.
5. According to Islamic governmental regulations in Iran, boys and girls go to separate schools from the first grade of elementary school (7 years old) to the end of the pre-college course (18 years old).
6. In this paper the term 'spatial knowledge' mainly refers to 'landmark' and 'route' knowledge in the framework of Piaget for acquisition of spatial knowledge. Less stress was placed on 'survey' knowledge in the assessment of the sketch maps drawn by children.