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A Comparative Investigation of Physical-Environmental Factors Affecting the Cognitive Skills of 9-12-years-old Children (Case Studies: [Primary] Schools of Shiraz University of Medical Sciences and Shiraz University)

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ABSTRACT

Cognitive skills refer to strategies that enable the user to encode and decode the environment and facilitate his mental process. Because the primary levels of understanding the space at lower ages involve greater flexibility, this study firstly aimed to identify the codes shared by children to understand the environment and to explain cognitive maps, and secondly to address their interrelations to provide strategies that would improve architectural performance and help strengthen children's skills of understanding the space. For this, a research method combining Delphi, survey, and case study was used. Following a review of past research, the views of 18 experts were investigated to identify the research criteria, which were prioritized by the Analytic Hierarchical Process (AHP). These factors were then analyzed by comparative case studies and evaluating the views of 412 9-12-years-old children using the SPSS software (version 24). Findings showed that spatial understanding skills were strengthened in three stages of the collection, reversibility, and classification of information. Regression test results indicated that children's cognitive skill variations in the mental collection and storage of information (the environment's physical data) were 0.875. This variation was 0.809 for the reversibility and visualization of information (the environment's symbolic data) and 0.808 for information classification (flexible interaction with and controlling and changing the environment). For this purpose, interaction with the environment and its flexibility were effective factors. Also, the involvement of multiple senses is critical for the collection and reversibility of information and the visualization of the environment. Other effective designing strategies include the provision of environmental comfort conditions, collective activities, attention to form capabilities, and focal signs.

Keywords: Mental Maps, Children, Interaction with the Environment, Cognitive Skills.

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1. INTRODUCTION

Experiencing the world that begins with the perception of the environment via human senses follows regular patterns of thought. This information turns into memories stored in a cognitive scheme. The human's behavior is also dependent on his understanding of the environment (Tarkashvand and Majidi 2013, 6). Cognitive maps derive from human's imagination of the environment. The images, formed in the mind in this way, will be completed in the long run and underlie the establishment of communication with the environment and conclusions about them (Ghods and Asgharzadeh 2014). These images include the elements from direct experience, what is heard, and the information received from the environment. These images include the appearance of the place and relative positions and values, which arise from the reciprocal communication between mental capacities with the impacts of the peripheral environment and human experiences in that environment (Lotfabadi 1987).

Our images of space, as posited by Lynch (1960), result from both momentary and memory senses caused by past experiences, which are formed as a product of a mutual process between the observer and the observed (the landscape). Analyzing such images involves three interconnected components; identity, i.e., what identifies a distinct subject, an object, and a landscape and distinguishes them from other things; structure, which is interrelated with the observer and other objects and landscapes, and the meaning conveyed by a certain object, a subject, or a landscape to the observer. Therefore, the ability to create an image (visualization) or receive an image is defined as the quality of the environment that gives the observer a greater chance of creating a strong image (Nawrocki 2017).

It is thus said that cognitive maps and mental images are familiar types of information that help the user to value the environment and improve his quality of experience with the environment. If defective, this process could make the user's mental comfort in the environment more vulnerable. In this connection, cognitive skills are signs and strategies that help the user to encode and decode the environment and expedite his cognitive process.

Cognitive skills enable children to process, evaluate, analyze, remind, compare, and perceive information and thus assist them with life skills. It is undeniable that not only do children need physical care but they also need social, emotional affective, and cognitive growth. Considering children's flexibility and role-taking, providing objective cognitive experiences in childhood ages could educate and raise them and be effective in regulating and controlling many of their performances (Sadeghi, Zainali, and Foroughi 2019). According to Piaget, the appearance of this cognitive ability in children is an intrinsic phenomenon strengthened by training and applying cognitive strategies and requires a stimulating and motivating environment.

Children spend most of their time in the school environment. The school is the first environment where the child has an independent presence, takes responsibility, receives a cognitive experience, and engages in social, emotional, and selective-assignment activities. This environment not only should support the scientific education of students but also help to strengthen cognitive dimensions and individual, social, and sentimental skills. Put simply, an environment structural design should prioritize the elements that significantly contribute to the child's perceptibility and memorization within the process of spatial design and planning, and regulate the child-environment relationship in the form of a dynamic cognitive relation. Previously, other research had discussed children's cognitive skills and some factors had been suggested for improving kinetic, educational, and learning skills. However, none of them attended to the architecture and the role of the physical environment as the living space of children. Thus, the present study aimed to answer the question "What are the physical-environmental factors improving children's cognitive skills?"

2. LITERATURE REVIEW

In the first step, the review of the literature helped to explain cognitive skills and the components affecting their definition and role in forming children's cognitive maps.

2.1. Cognitive Skills

Environmental stimuli are initially received by the senses and stored for a very short time in a repository called sensory memory. Through the processes of attention and perception, part of the information transmitted to the sensory memory is transferred to another repository, i.e., the short-term memory, and is then transferred to the last repository, i.e., the long-term memory via the strategies of mental review and repetition, semantic expansion and organization. The strategies that help facilitate this process are known as cognitive and meta-cognitive skills (Rouhani et al. 2006, 74). Working memory is the central core of many cognitive functions (Khorasanizadeh, Bahrami, and Ahadi 2020). As one of the three components of active memory, working memory not only stores spatial-visual information in the short run such as objects and their places but it also produces and manipulates mental images, and helps to create and develop mental models of space (Dehn 2011).

Bloom et al. classified cognitive levels into six classes: knowledge, comprehension, application, analysis, synthesis, and evaluation (Pappas, Pierrakos, and Nagel 2013) (Fig. 1). Bloom's classification of cognitive growth takes the shape of a concrete-to-abstract hierarchy. The first three levels (knowledge, comprehension, and application) require primary identification and reversibility and are seen as lower-order cognitive skills. On the contrary, the other three levels (analysis, synthesis, and evaluation) require using higher-order cognitive levels (Salehinejad et al. 2017, 9).

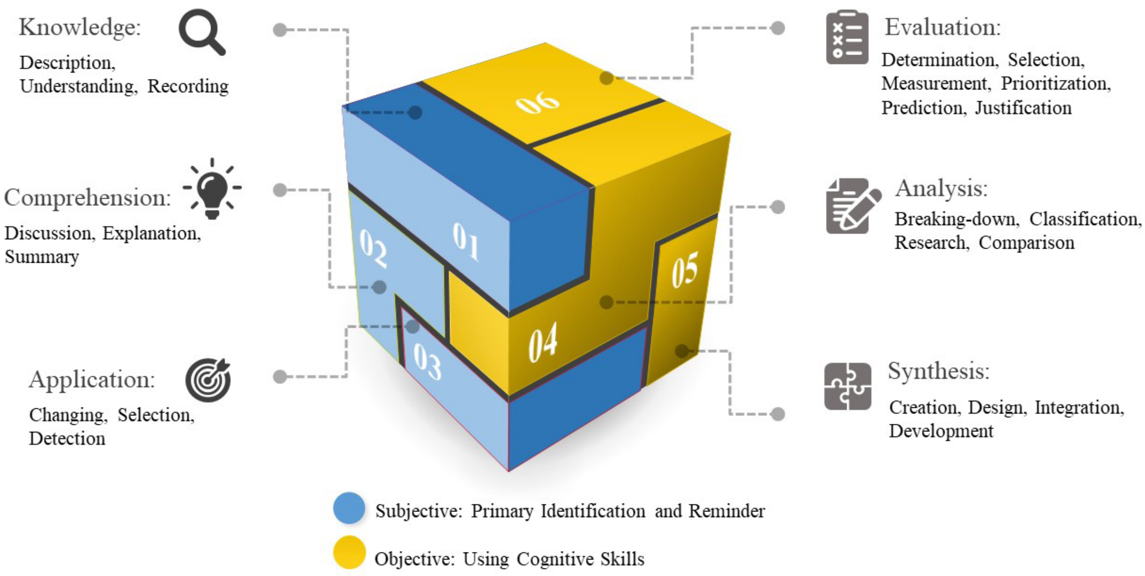


Fig. 1. Cognitive Skill Levels based on Bloom's Model
(Pappas, Pierrakos, and Nagel 2013)

Piaget propoes four main growth stages: (1) the sensorimotor stage from birth to 1.5 years when the child's senses and movement underlie his growth and help him discover the relationship between his actions and reactions, as this would help him to find out such concepts as objects, space, and time; (2) the preoperational stage from 1.5 to 7 years when the child learns the language, visualizes, and establish wider relations with others, as well as symbolic thinking. Here, the child can distinguish between objects and his senses; (3) the concrete operation stage from 7 to 11 years when the child can achieve rational concepts, discover laws, and find well-established relationships that are stable. Also, the child can, in this period, investigate and classify each object or event from various aspects, and (4) the formal/rational operation stage from 12 years onwards when the child enters the abstract stage. Here, the child tries to coordinate the surrounding environment with himself, in addition to coordinating himself with the surrounding environment (Barzin 2012, 34). Piaget emphasizes that cognitive growth is not achieved by direct education; rather, the individual needs to obtain his knowledge and understanding in a dynamic interaction with objects, humans, and the environment (active experience), and expand his schemata (Parirokh, Naderi, and AghaMohammadian 2011, 154). Put simply, children perceive affairs through their direct experience with the surrounding environment, and they are expected to reflect more cognitive information, especially in the last two stages of cognitive development. In this process, one of the most critical strategies is mental and cognitive mapping, which is a technique to organize a network of information that consists of physical, verbal, and symbolic elements. This technique is generally used to emphasize the individual's active interference that makes use of the existing knowledge to combine new information with existing content (Dhindsa, Kasim, and Anderson 2011).

2.2. Cognitive Map

As part of mental image, a cognitive map focuses specifically on spatial relations and provides internal representations to simulate environment-specific spatial characteristics (Pirbabaei, Gharehbaglou, and Alinam 2015). The term Cognitive Map was first developed by Edward Tolman (1948) to refer to how people think about space and reflect it in their behaviors. Cognitive maps serve as tools to organize and store spatial information which help to recognize and interpret the environment by recalling its elements and components and how they are interrelated. Therefore, cognitive maps are an accumulated understanding of the environment and the environmental mental concept characteristics (Pourjafar et al. 2012). Over the last several decades, many researchers studied the concept of environmental perception and mental maps, as well as the reciprocal human-environment relationship. This research includes a large number of classic works such as Lynch's City Image, Jane Jacob's Life and Death of Great American Cities, and Bentley et al.'s Responsive Environments in 1985. To add to this list, there is a huge body of articles that are beyond the scope of this present study.

Concerning mental images, past research suggests two concepts of the environment and the user which, in an interactive relationship, would eventually lead to a definition of mental image. Regarding the user, cognitive skills and perceptual processes are focused to investigate the environment and form the desired cognitive map. Regarding the environment, the information and characteristics contained therein can be investigated. Hollander and Foster define one of the characteristics of the environment to be imaging and recalling the environment. Quoting Ewing and Bartholomew (2013), Hollander and Foster argue that imaging the environment refers to the human's intrinsic abilities to see and recall patterns. However, this is more than a mere stimulation of feelings and is a quality of the environment as the human brain looks for environmental patterns. They also maintain that our five senses for environmental perception are not equally prioritized in the perceptual system and cognitive processes, as the sight sense takes a higher priority for the brain.

Most research on special environments is mostly limited to environmental semantic and symbolic data (implicit meanings). While the explicit meanings of a physical environment may look clear at first glance, i.e., the user, upon seeing an environment, easily understands the functions of that environment as a university, mosque, school, etc., the design of this explicit meaning assumes importance at the scale of designing and planning, as it would lead to the user's design of the environment. For this, it is required to view the environment as a space with an information load.

Table 1. Children's Cognitive Skills and Maps from the View of Scholars

Authors	Years	Factors
Pourjafar et al.	2012	Easy identification of environmental components (size and complexity, capability of surrounding, and purposeful communication)
Goudarzi Soroush and Jafarikhah	2014	Opportunity to collect information and the encouragement of the individual by the environment
Mostaghimi, Goudarzi Soroush, and Daneshgar Moghadam	2015	Strengthening the image of place by making the environment recognizable with marking paths and places or changing physical organization
Turgay et al.	2015	Activity experiences and sentimental reactions to the environment
Turgay et al.	2017	Spatial information is stored, reconstructed, and completed in the form of objects, places, positions, and their interrelations
Nawrocki	2017	A quality of the environment that gives the observer a higher chance of creating a strong image
Ghoraba and Tabibian	2017	Three physical, functional, and semantic dimensions prioritized by spatial analyses
Sadeghi, Zainali, and Foroughi	2019	Using similarities and repertoire of previous information, and the child's visual-kinetic encoding, spatial-visual enrichment, and attraction of attention and focus
Khorasanizadeh et al.	2020	Strengthening orientation skills and strengthening visual-hearing memory in children
Majidi, Mokhtabad, and Etesam	2021	Orientation, spatial visualization, and mental image reconstruction
Esmailirad, Zargham, and Monirpoor	2022	Mental and verbal repetition and review (e.g., giving an address), giving meaning

3. METHODOLOGY

As an applied study with a quantitative approach, this present study aimed to investigate the effects of a physical environment on improving children's cognitive skills. First and foremost, past research was collected using the descriptive approach and via library data. Here, the concept of cognitive maps and skills was defined per the research approach. Second, the children, as the target community, and experts, as theorists, were asked to introduce the components and criteria influencing the children's cognitive skills. In this stage, children provided a cognitive description of their school environment and experts provided an account of classified components. Then, the final criteria were weighted based on expert views, and the obtained quantitative data were eventually analyzed using appropriate statistical methods in case studies.

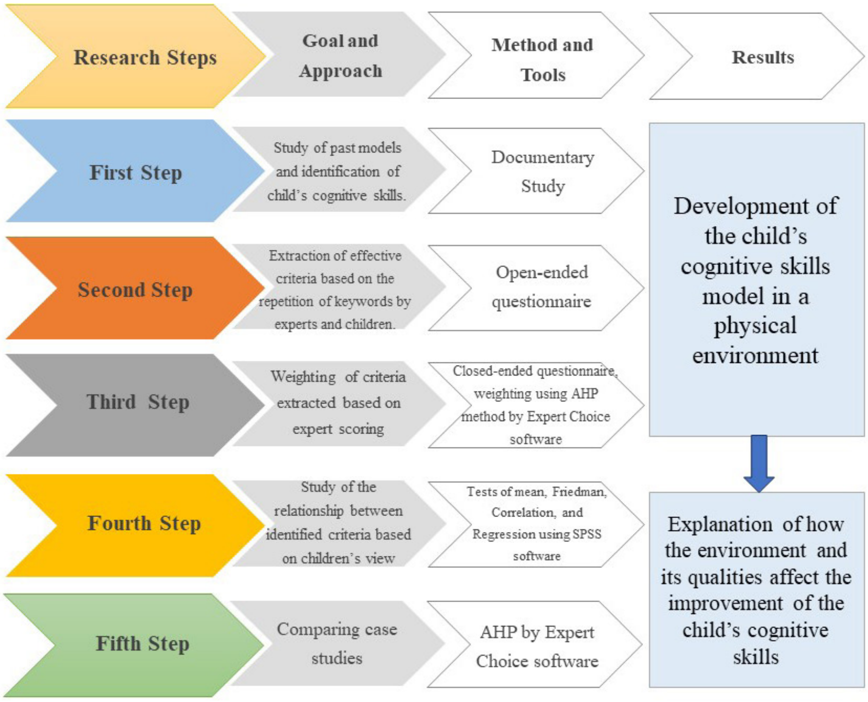


Fig. 2. Research Method and Process

3.1. Analysis Method and Instruments

A Delphi study is a systematic research method to extract the collective views of experts about a topic of interest. These experts usually amount to 10 to 20 people. In the first stage of the present study, an open-ended questionnaire was provided to people to identify the key factors affecting the research hypothesis based on the times of repetition. To this end, the experts were asked to introduce the cognitive stages and the factors that they think would contribute to the formation of children's cognitive maps. The children were also asked to respond to some questions about the description, the importance, or the presence of each of the introduced variables about their schools. The results of this questionnaire were used to define close-ended items in the second questionnaire. Hence, the main variables of the study were identified. These factors were classified in this domain, according to prior research. Then, a 20-item questionnaire was designed to ask the experts to prioritize the factors within a 1-5 scoring range. Cronbach's alpha value of the questionnaire was generally 0.870. This process was repeated in three stages to identify and remove unnecessary criteria. The identified factors were weighted by the AHP method and using the Expert Choice software. Next, by considering the repetition of the keywords described by the studied children, the scoring of each of the case studies began from 1 to 5 for each component, and the results were examined by the SPSS software. Data were analyzed by tests of Friedman, comparison of means, correlation, and regression. Last, the test results were used for presenting the conclusion, via field observations and using the descriptive-analytical method of the content.

Table 2. Items in the Open- and Close-Ended Questionnaire

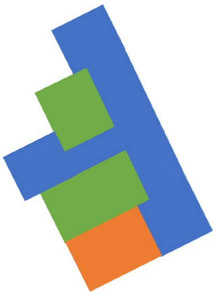
Question No.	Children's Open-Ended Question Content	Cronbach's Alpha	Question No.	Experts' Close-Ended Question Content	Question No.	Experts' Open-Ended Question Content
18	Description: School forms, elements in the school, the first things they recall from the school, good and bad points of the description of the school environment, materials, smell, sound, the best part of the environment, differences between positive and negative points of the school environment compared to other schools, favorite place, wherever they like to change, the beginning and ending points of the school, hangout of the school and activities in there, confusing and frightening areas in the school, access points to the school environment	-	4 items; each with three subsets	Variable Prioritization	1	Introducing the stages and factors affecting the improvement of children's cognitive ability
		0.854	6	Mental Collection and Storage of Environmental Information	1	Introducing environmental and physical factors to define the school environment
		0.691	6	Reversibility and Visualization of Environmental Information	3	Introducing the factors that separately affect the collection, visualization, and classification of environmental information in the school.
		0.520	4.2.	Environmental Information Classification		

3.2. Case Studies

It is highly important to select appropriate case studies to generalize the results. Selecting schools with highly desirable or undesirable architectural qualities or a student community from a special social class could affect the results. Then, in terms of environmental facilities and qualities, attempts were made to select schools that met the minimum quantitative and qualitative per capita requirements based on children's physical and educational needs. Also, because the Department of Education was quite sensitive to issuing permission for the practice of field studies in the schools, the respected experts at the Research Institute for Teachers, affiliated with the Fars Province's Department of Education were consulted to select the School of the Shiraz University and the School of Shiraz City's Medical Sciences as final case studies.

Table 3. Overview of the Case Studies

Case Studies	School of Shiraz University of Medical Sciences	School of Shiraz University
Place	Chamran Blvd.	Mahdi Alley
Image	 	 

Case Studies	School of Shiraz University of Medical Sciences	School of Shiraz University
Aerial Image	 (https://earth.google.com/web)	 (https://earth.google.com/web)
Closed Space Green Space Open Space		

3.3. Participants in the Study

This study was performed in the educational year (2019-2020) when a total of 412 students, from third-grade students to sixth-grade students, were studying and participated in the study. First and second-grade students did not take part in the tests as they could not answer the questionnaire items in writing and the test giver's interpretation of their explanations could have been confusing. Also, based on the age ranking stated in the Literature Review Section, the age group was expected to be 9-11-years-old children; however, as outlined by Iran's Educational System, 7-12-years-old children study at primary levels, i.e., from first- to sixth-grade classes and fall under a similar cognitive environment. Therefore, the statistical population of this study was composed of 9-12-years-old children (third to sixth classes) as well as 18 experts in child cognitive domains, including child psychologists, instructors and counselors, and some teachers.

4. FINDINGS

In the following, collected data are analyzed to test the study question and hypothesis. After research components were explained, they were prioritized and the identified criteria were eventually compared in the case studies.

4.1. Explaining the Components Affecting Children's Cognitive Skills in the Physical Environment

Table 4 gives the factors affecting the child's environmental cognitive skills introduced by experts and children in the open-ended questionnaire.

Table 4. Indicators introduced by Experts and Children

Factor introduced by Experts	Factor identified in Children's Answers
Architectural form and Design	Describing the overall form of the school
Interactions	Hangout place in the school
Physical Facilities	Existing elements and facilities in the school
Rich Environmental Data	Things they recall from the school
Capability of Synthesis and Abstraction	Difference between positive and negative points in the school environment compared to other schools, the best and the worst parts of it
Distinction and Complexity	Good and bad points of the school environment, the beginning and ending points of school description, confusing and frightening areas

Factor introduced by Experts	Factor identified in Children's Answers
Readability	Pause paths, access, and movement to the school environment
Senses	Materials, smell, sound, color, etc.
Playing, Movement, and Activity	Activities they perform in the school environment, especially in the hangout

A review of the components mentioned above indicates that these factors fall under three categories of Bloom, Piaget, Majidi, Mokhtabad, and Etesam (2021) theories. In a final classification (Table 5 and Fig. 3), experts were consulted to integrate some factors due to their similar nature and content. For example, environmental enrichment was thought of as equal to environmental physical and tangible signs.

Table 5. Components Affecting the Children's Cognitive Skills in the Physical Environment

Bloom Model	Iaget Model	Majid et al. (2021)	Present Study Model	Environmental Data	Factors Affecting the Reception of Environmental Data	Sources
Knowledge (Comprehension and Collection of Information)	Sensorimotor (Comprehension of Concepts)	Spatial Orientation	Mental Collection and Storage of Information	Physical Data	Physical and Tangible Signs and Elements of the Environment	(Nawrocki 2017; Dhindsa, Kasim, and Anderson 2011; Pourjafar et al. 2012; Mostaghimi, Goudarzi Soroush, and Daneshgar Moghadam 2015; Ghoraba and Tabibian 2017)
					Involvement of Multiple Senses	(Picinaliet al. 2014; Xing et al. 2016; Beydoghan and Hayran 2015; Stephenson 2002)
Comprehension	Visualization and Communication (Perceiving Distinction)	Spatial Visualization	Reversibility and Visualization of Information	Symbolic Data	Involvement of Multiple Senses	(Picinaliet al. 2014; Xing et al. 2016; Beydoghan and Hayran 2015; Stephenson 2002)
Applicability					Time, Movement, and Activity (Hierarchy of Information)	(Turgay et al. 2015 & 2016; Beydoghan and Hayran 2015; Goudarzi Soroush and Jafarikhah 2014; Ghoraba & Tabibian 2017)
Analysis (Comparison)	Logic and reasoning (discovery of rules)	Image Reconstruction	Classification of Information Received	Architectural Data	Architectural form and Design	(Turgay et al. 2015; Mostaghimi, Goudarzi Soroush, and Daneshgar Moghadam 2015)
Synthesis (Construction)	Abstraction and Interaction (Coordinating and being coordinated)					
Evaluation						

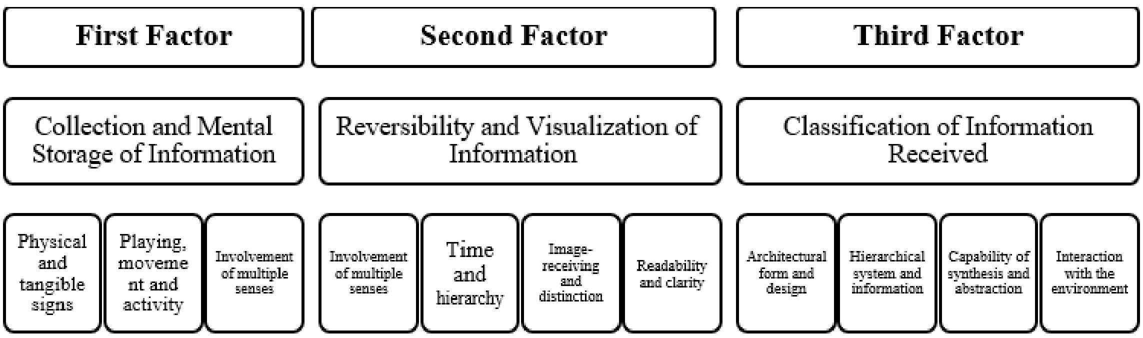


Fig. 3. Factors Affecting the Improvement of a Child's Cognitive Skills

4.2. Prioritization of Physical-Environmental Variables Affecting the Improvement of Children's Cognitive Skills from the View of Experts

The Friedman test result (a significance coefficient of less than 0.05) rejects the stated equal priority of the components. The Friedman test only examines the hypothesis of the equality of the variable importance. However, which factor is of a higher importance cannot be inferred with certainty from this test result. To determine the relative importance of these factors, the pairwise comparison and the AHP methods were used to determine the weights of each factor, as given in Table 7.

Table 6. Friedman Ranking for Examining the Equality of the Importance of the Components from the View of Experts

		Ranking Mean	Chi-Square Statistic	Freedom Degree	Sig.
Components	Mental Collection and Storage of Environmental Information	2.58	10.571	2	0.005
	Reversibility and Visualization of Environmental Information	1.75			
	Classification of Environmental Information	1.67			

Table 7. Weighting Criteria for Improving the Child's Cognitive Skills in the Physical Environment from the View of Experts through the AHP Method

Main Criteria	Weight A	Sub-Criterion	Weight B	Final weight A*B
Mental Collection and Storage of Environmental Information	0.109	Environmental Physical and Tangible Signs	0.063	0.007
		Playing, Movement, and Activity	0.265	0.029
		Involvement of Multiple Senses	0.672	0.073
Reversibility and Visualization of Environmental Information	0.309	Involvement of Multiple Senses	0.678	0.21
		Time and Hierarchy	0.127	0.04
		Readability and Clarity	0.149	0.046
		Visualization and Distinction	0.046	0.014
Classification of Environmental Information	0.582	Architectural Form and Design	0.113	0.066
		Information Hierarchical System	0.067	0.039
		Capability of Synthesis and Abstraction	0.334	0.194
		Interaction with the Environment	0.486	0.282

4.3. Investigating Children's Cognitive Skills about the Physical Environment in Case Studies

To determine whether or not environmental design can help to improve the child's cognitive skills, the two selected schools were compared based on the intended criteria. A review of the children's responses and the T-test results (Table 8) shows that all three factors introduced were highly important in recalling the environment. Also, the correlation test results demonstrated a relationship between the three factors introduced and the child's cognitive skills (Table 9).

Table 8. Mean Statistics of the Main Study Criteria

	Mean	SD	T	Freedom Degree	Sig.	Mean diff.	Confidence Distance of 95%	
							Lower Bound	Upper Bound
Mental Collection and Storage of Environmental Information	4.47	0.4740	1.961	411	0.000	1.47222	1.2497	1.6947
Reversibility and Visualization of Environmental Information	4.18	0.40378	12.453	411	0.000	1.18519	0.9844	1.3860
Classification of Environmental Information	4.06	0.48169	9.297	411	0.000	1.05556	0.8160	1.2951

Considering the children's responses in recalling the school environment, describing the details, repeating the special keywords, understanding the environment adequately and desirably, etc. their cognitive skills in each of the three factors mentioned above were scored from 1 to 5. Since cognitive skills cannot be properly measured by asking several questions, its value as a dependent variable was rated by calculation based on the three main components, as follows: the cognitive skill score of each child was calculated by multiplying the scores of each component by its weight. The score of each component was considered based on the child's success in providing maximum descriptive information and the keywords repeated in the open-ended questionnaire.

Cognitive skills= 0.109 (the number of keywords related to the mental collection and storage of environmental information) + 0.309 (the number of keywords related to environmental information reversibility and visualization) + 0.582 (the number of keywords related to the environmental information classification).

Table 9. Correlation Test

		Mental Collection and Storage of Environmental Information	Environmental Information Reversibility and Visualization	Environmental Information Classification
Child's Cognitive Skills	Correlation Coefficient	0.770^{**}	0.807^{**}	0.788^{**}
	Sig.	0.000	0.000	0.000

The regression test was used to explain the causal relationship between variables and determine the quantity of the cognitive skills, as given in Table 10. Analysis of variance results (a significance coefficient of 0.000) confirms the significance of the regression model, and the F indicator enjoys a good fit. The regression test results showed that the children's cognitive skill variations in the mental collection and storage of information (environmental physical data) dimension was 0.875. This variation rate for the dimensions of reversibility and visualization of information (the symbolic data of the environment) and the dimension of information classification (flexible interaction with the environment, controlling and changing it) were 0.809 and 0.808, respectively.

Table 10. Predictability of the Criteria in Strengthening the Child's Cognitive Skills by the Regression Test

	Analysis of variance		Regression model						
	F	Sig.	Correlation Coefficient	Coefficient of Determination	Modified Coefficient of Determination	Non-standardized Coefficient B	Standardized Coefficient Beta	t	Sig.
Information Collection and Storage	52.275	0.000	0.875	0.766	0.751	0.722	0.875	7.230	0.000
Information Reversibility and Visualization	30.344	0.000	0.809	0.655	0.633	0.740	0.809	5.509	0.000
Information Classification	30.118	0.000	0.808	0.653	0.631	0.619	0.808	5.488	0.000

A review of the case studies (Table 11 and Figure 4) indicates that the school of Shiraz's University of Medical Sciences (the blue diagram) has generally a more desirable condition for the improvement of the children's cognitive skills. This was made possible in information collection by providing more environmental data and in information classification by providing the possibility of interaction with the environment and people using collective spaces. Meanwhile, the school of Shiraz University (the red diagram) has facilitated the encoding and reversibility of environmental information via a user-friendly, readable, and clearer design. Both schools apply such strategies as the use of green color and space to involve multiple senses, which help to provide relatively desirable conditions for both information collection and reversibility and visualization.

Table 11. Final Weights of Sub-Criteria in Case Studies based on Expert Views in the Expert Choice

Main Criteria	Sub-Criteria	School of Shiraz University of Medical Sciences	School of Shiraz University
Mental Collection and Storage of Environmental Information	Physical and Tangible Signs	0.005	0.001
	Playing, Movement, and Activity	0.019	0.003
	Involvement of Multiple Senses	0.048	0.048
Reversibility and Visualization of Environmental Information	Involvement of Multiple Senses	0.138	0.138
	Time and Hierarchy	0.009	0.026
	Readability and Clarity	0.006	0.030
	Visualization and Distinction	0.005	0.009
Environmental Information Classification	Architectural Form and Design	0.022	0.043
	Information Hierarchical System	0.009	0.026
	Capability of Synthesis and Abstraction	0.127	0.042
	Interaction with the Environment	0.185	0.062
Final Ideal Weight		0.572	0.428

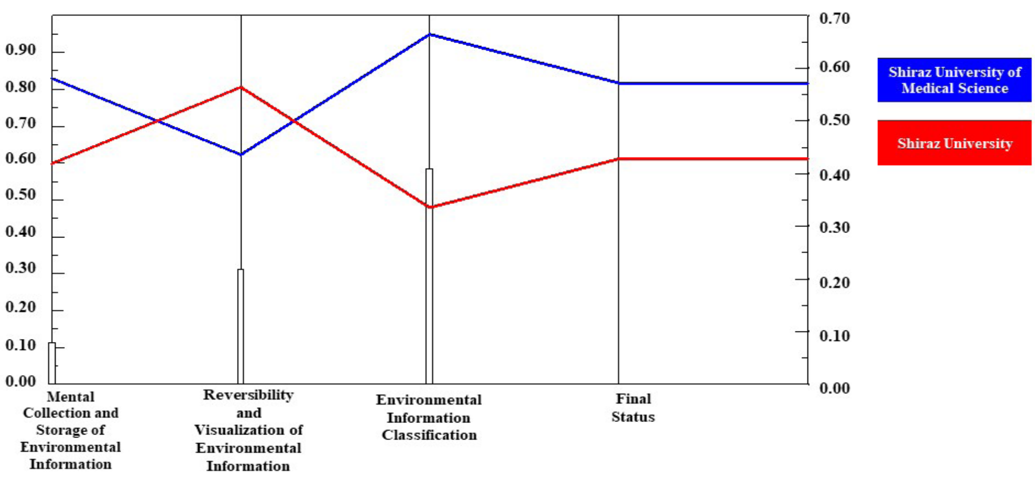


Fig. 4. Analysis of Sentiment of the Efficiency of the Case Studies in the Expert Choice Software

5. DISCUSSION AND CONCLUSION

Cognitive strategies refer to behaviors and thoughts that affect the storage process and effective retrieval of information in the memory. These strategies enable one to prepare new information to combine with previous information and store it in the long run. The individual is himself considered a part of the environment who, via his behavior and movement in the environment, plays an effective role in defining the scope of its limits and properties. Meantime, architecture as a sensory stimulus plays a determining role in the process of understanding the environment and perceiving the user's situation in the environment. Understanding the environment occurs in a process of collecting, reversibility, and visualization, and finally classification of information in the memory. Cognitive skills serve as strategies to encode and decode the environment and thus help facilitate the user's cognitive processes. To improve children's cognitive skills, it should be realized which environmental data they are more affected by and how they can enrich these data in the environment. Confirming the findings of the study by Sadeghi, Zainali, and Foroughi (2019), the findings of this study demonstrated that cognitive skills influenced children's cognitive and executive abilities. The results also showed that the best choice, as experts highlighted, to measure the children's cognitive skills is to determine the child's abilities in classifying the information received. Also, to strengthen children's cognitive skills is to help them improve the reversibility of the information received from the environment; this finding corresponds with the visualization of mental images, suggested by Majidi, Mokhtabad, and Etesam's model (2021).

The strong points of the study include a comprehensive approach to the children's cognitive process which has encompassed various dimensions of cognitive skills in strengthening active and inactive perception of the environment. Other research, meantime, has emphasized aspects of cognitive skills; for instance, Davis et al. (2015) stressed the [cognitive] mapping and designing and Adibi (2003) stressed the ability to visualize information, or Alitajer and Sajadi (2018) focus on understanding the volumes, understanding the form and determining formative relations, without attention to reconstructing mental images.

However, the regression test results of the case studies showed that, unlike expert prioritization, children undergo the hierarchical process of collection to the classification of information. The reason for this, as evidenced by Bloom and Piaget, is that children first try to understand how they can communicate with the environment and thus find information collection as necessary. For this, designers need to focus on the quality and quantity of signs within the elements defining the environment and stimulating the senses to collect and store information from the environment. As the child gets to understand the concept of the environment and its hierarchy, his cognitive operations begin encoding and laying the signs instead of realities in the mind. At this stage, the child uses his subjective signs to reconstruct the information collected and thus recall an overall mental image. Finally, the perceived concepts will be classified by their common and distinguishing points and results in the perfection of environmental understanding. At this stage, the interaction with the environment occurs dynamically which enables the child to perceive his position in the environment and vice versa.

As stated, a review of the case studies indicated that at the school of Shiraz University, the readable design of the environment would be effective in the systematic reception of information and facilitate the reversibility and visualization of that information. In the meantime, the school of Shiraz University of Medical Sciences has facilitated the interaction between the environment and people in it and thus expedited the exchange of information received, while helping discover the various aspects of the environment and collective activities. This school has also played a more effective role in classifying and strengthening the children's ability of synthesis and abstraction, as well as in perceiving an environment distinct from their prior mental information.

This study also suffered from some limitations; for example, the study was carried out in a short period due to the outbreak of such diseases as flu and Coronavirus. Future research is thus recommended to take a longer time to better investigate children's cognitive skills in the environment. Other limitations include the prohibition of the schools' educational personnel to investigate control and experimental groups. Despite these limitations, the environment was found to be effective and positive in developing primary school children's cognitive skills.

To provide a final summary of the findings and an objective evaluation of the case studies and the environmental capacity, Figure 5 below offers some strategies to strengthen children's cognitive skills.

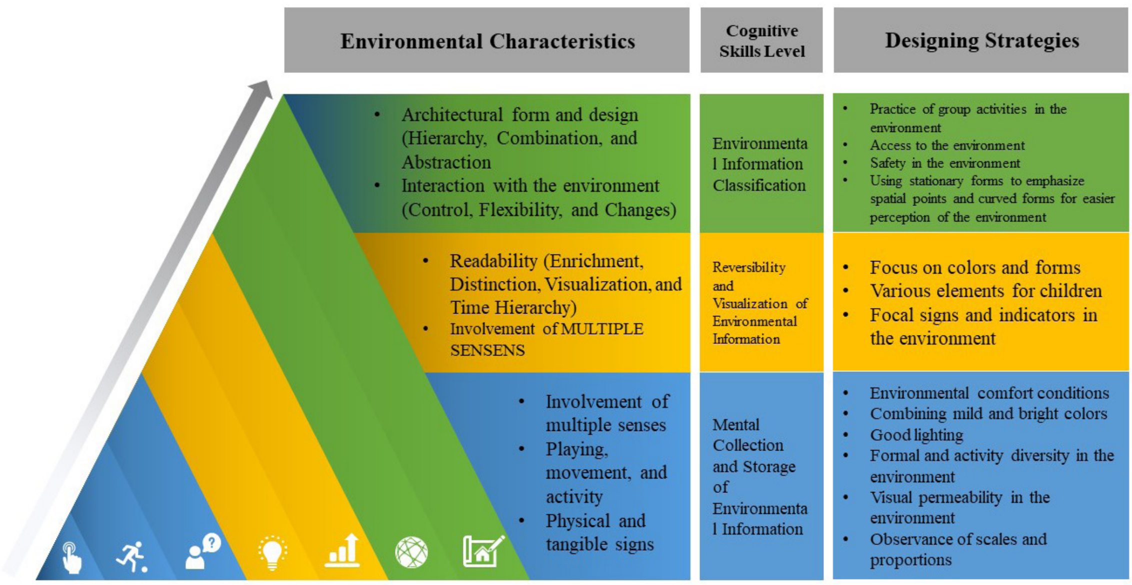


Fig. 5. Strategies Affecting the Improvement of the Child's Cognitive Skills in a Physical Environment

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

MORAL APPROVAL

The authors commit to observe all the ethical principles of the publication of the scientific work based on the ethical principles of COPE. In case of any violation of the ethical principles, even after the publication of the article, they give the journal the right to delete the article and follow up on the matter.

PARTICIPATION PERCENTAGE

The authors state that they have directly participated in the stages of conducting research and writing the article.

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