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The Role of Architecture Education on Architectural Space Perception of Blind Students (Study Group: Blind Students of Tabriz Cultural Art Institute of Basir)

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Abstract

For a long time, the sense of sight has been regarded as the greatest sense of the human being and it is the most powerful transitional sense which plays a significant role in understanding other emotions. On the other hand, according to the world-wide experience of the perception process and its results, there are some differences between the normal people and the blind people. This subject has been independently investigated by many researchers, but without the full attention of the blind perception processes and their associated mechanisms, no interventions and planning can be undertaken for the improvement of the environmental quality of this group. In this regard, in the form of an experimental activity, by writing a syllabus extracted from the curriculum and topics by the Ministry of Science's Planning Supreme Council and by applying appropriate and adaptable approaches to the physical condition of the blind students, basic architectural training is considered for them. The findings of this study were analyzed by inferential analysis of T-test through comparing the analysis of pre and post-tests of the training courses and then by analyzing the results and measuring the significance level of the results. The findings showed that using basic architectural training methods can have a significant effect on the quality and quantity of blind people's perception from the architectural spaces. Also, the results showed that through architectural teaching methods, the blind people can participate in designing the public spaces specific for them.

Keywords: Blind Education; Architecture Space Perception; Blind Perception; Architecture Education

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1. Introduction

Human perception and the way of his/her interaction with the world is one of the most important issues in creating the architectural works. Since human perception of existence shapes the level of his/her interaction, in order to improve the quality of the created architectural and urban works, it is necessary to understand the level and different stages of human perception (Taghdir, 2017: 49). Architecture is one of disciplines in which discussing on the human beings is necessary. It has been widely stated that in designing or criticizing an architectural subject, one speaks of the perception of space or the emotion emanating from it (Iravani, 1992: 1). Architecture is also the first tool for human communication with space and time and gives them a human sense. Architecture dominates the endless space and time for the human companionship, residence and understanding. Due to the interdependence of space and time, the dialectics of inner and outer space, material and spiritual, physical and mental, and the priority of consciousness and subconscious in sensory perceptions such as interdependent roles and their interactions, they have a major impact on the nature of art and architecture (Levin, 2003: 205). The environment is used as the source of information by the human. In human and environment contact, the first question that arises is what information is present for a human being and the initial answer is the surrounding environment. A person's feelings convey some information about the environment, so we can review the information that the sense have revealed to us (Shafii and Sharifi Daramadi, 2006: 21). The range of diagnosing the sensory organs, individual abilities and other factors play an important and decisive role in this perception. Also, based on special conditions, some senses are more important than others. These conditions include the disability of a person sense or being in different cultures (Hatami and Rashid Kallivar, 2014: 1). On the other hand, the global changes requires people to acquire some skills to deal with the challenges ahead, and that requires us to pay attention to the people training because it is believed that most modern developments root in the knowledge and skill so that their acquisition requires learning (Feizi and Dejpasand, 2018: 150). Based on the mental model governing the learning process, the learner receives a vast variety of visual information through the experience of the works and through his or her senses in which the sense of sight plays a major role. All of the received information is stored in the sensory memory. At this point, the learner, or in other words, the observer will consider a part of this image. In such a case, the focus shifts this piece of information from the sensory phase into the perception process, in which the mind organizes and interprets the received information through the senses, in order to make sense of them (Centrack, 1991: 25).

The new approach to learning is consistent with the meaning of learning in which education means re-building or revising the experiences and reforming them for further growth (Ayat and Khoshdaman, 2012: 152). People's potential for learning is different, and people learn under different situations and different factors. Considering the individual differences of learners and the fact that everyone learns in their own way and has a different perspective for themselves is essential to make learning more effective (Feizi and Dejpasand, 2018: 150). Learning styles define the learning differences between individuals. In fact, learning styles can be considered as different ways of organizing and processing information and new experiences in mind (Khandaghi and Rajaii, 2013: 22). Blind students mainly prefer scientific, reflective, and organized styles in learning. Blind people, since they always have to make a picture of the environment and what they want to do, are reflecting on the work beforehand and act based on the small organizations that they have created in their minds. For example, when a blind student goes to university, he/she draws a map of the college and university before moving on and organizes them and then moves on (Austin, 2009: 1).

2. Research Questions

1. How can we increase the level of architectural space perception in the blind people?
2. Is there a significant difference in terms of the spatial perception level of the blind people between those who have been trained in architecture and those who have not been trained in architecture?

3. Overview

The present study was carried out at Basir the first Cultural and Art Institute for the blind students in Tabriz. The purpose of this study was to investigate the perception of the blind people from the architectural space as well as the relationship between basic architectural educations as an effective factor in the spatial perception. After examining the basic concepts in the perception and emotion process as well as analyzing new ways of teaching the blind students, the authors put forward some hypotheses and through basic architecture training based on the syllabus extracted from the curriculum and the introductory courses of architecture introduced by the High Planning Council of the Ministry of Science and also applying some techniques appropriate to the physical condition of the students, they experimentally started teaching architecture to the blind students. Through experimental tools, this study examines the results of a three-step process including pre-training, introductory training and post-training steps. During these processes, in the first stage, ten qualitative questions were asked about the spatial perception of the blind students; then in the second stage, through introductory architectural training based on the above mentioned results, scientific and practical discussions were conducted with the blind students; in the third stage, a test was conducted to determine the blind students' perception of the architectural space and analyze the results of this training. The qualitative data obtained from the first and third stages were finally collected and compared with the hypotheses of the study through statistical and inferential and comparative analysis. The research concludes with a summary of the results of the relevant analyses and validates the research hypotheses.

Given the presence of human participants in this research, we attempted to observe all research ethics in the social sciences, including informed consent, privacy, anonymity, confidentiality and being free from any harm. Also, in publishing the results of the research, some issues such as universality and honesty have been considered by the authors. In addition, according to the researches and studies carried out to achieve the aims of this research, it was clear that no research has been conducted in Iran on the basic training of architecture for the blind students.

4. Research Method

According to the qualitative-quantitative research methodologies, the data collection tools were library studies, observation, direct participatory, participatory observation and interview, focused group type, conceptual and discourse interview. The reliability was verified by parallel methods or peer tests, and for the validity was verified by construct validity (group differences and variations). Considering the quantitative-qualitative research, constant comparative analysis methods, construct-event analysis, idea design, Mapping and finally illustrating data through diagrams, charts, tables, and graphs were used, and ultimately the items were compared.

Table 1 Data collection method

Methods of data collection	Library Studies	Data literature review and theoretical framework, analysis and review of past research results
	Observation (field studies)	Direct participation
		Participatory observation
	Interview	Focused group
		Conceptual interview
		Discourse

Reference: (Hakimzadeh and Abdolmaleki, 2011)

5. Basic Concepts in Perception

Perception is a biological and psychological process of acquiring information from the environment. Environmental perception factors are categorized by psychologists and architects in different groups; Edward T. Hall divides spatial perception into intermediate receptors that include the eyes, ears, nose, as well as intermediate receptors like the skin and muscles (Amrollahi and Soltanzadeh, 2016: 3). Environmental perception factors can be broadly divided into two visual and non-visual categories:

A) ***Visual factors***: For a normal person who is not blind, the sight sense has the highest share in understanding the surrounding space. Seeing is a physical phenomenon which has been made possible by the presence of light. Light is the wavelength of radiation in which each wavelength has its own color and heat. It is said that the blind people can also perceive the colors of light through the heat generated by the particular wavelength.

B) ***Non-visual factors***: Among the other factor affecting the environmental perceptions are smelling, hearing, touching (physical contact) and temperature (Amrollahi and Soltanzadeh, 2016: 4).

Smell: Emission of evaporable substances in the air provides the ability to smell. Some scents are specific to one place, for example, when you go to traditional Iranian markets; each part of the market has its own smell.

Hearing: Sound is transmitted like waves through light. The sound is partially reflected in the enclosed and semi-enclosed spaces and does not pass through the vacuum. Hearing familiar voices from different people or spaces increases the intimacy and gives them a pleasant feeling.

Temperature: The temperature directly affects the skin of the body. You can detect congestion in a space by measuring the temperature. When placed in a cold environment, the human body shrinks; for example, the results of a research show that it easier to tolerate a certain number of people in a closed room at a lower temperature than the same number of people at a higher temperature.

Physical contacts: Physical contacts, including touching, is also one of the ways of perceiving the environment. It is also likely that you have withdrawn, upset, or apologized when dealing with a stranger, and that touching a hot object has forced you to quick reaction.

In sum, we can conclude that perception is a process in which the individual receives information from his/her surroundings and then analyzes and evaluates it in the mind. Three factors play a very important role in perception:

1. The spiritual state of person at the time of perception and the condition of the environment at that moment

2. The person behavior which is embodied and made up of all the past experiences and events

3. Hereditary factors and the social, psychological context that are created neither by learning nor by the experience.

The personal differences make people have different spatial perceptions. Environmental perceptions may be different from each other. Robert Gifford, on the other hand, suggests several factors to justify the perceptional differences (Amrollahi and Soltanzadeh, 2016: 4).

A) Personal factors: such as personal experiences, age, gender and education

B) Cultural factors

C) Physical factors

The emotion and perception in psychology today is referred to as "sensory perception" which is mainly based on the achievements of empirical sciences and especially physiology in empirical psychology. In these sciences, sensory perception is a process that begins with the physical and chemical stimuli of the environment and ends with the reacts of living organisms and the psychological analysis and interpretation that compromises it with their environment (Shafiei and Sharifi Darmadi, 2006: 31).

6. Perception in Blind People

Space perception of everybody depends on his/her deals with space and the extent of the use of the senses for understanding it. The main difference between the blind and non-blind people in the perception of space relates to their use of senses, and since the blind people live without the sight sense, they compensate their problem by hiring other senses (Farzin and Shebani, 2010: 62). Human perceptual stimuli with zero visual perception can be generally divided into six categories: hearing stimuli, smelling stimuli, tasting stimuli, touching stimuli, physical (skin) stimuli, natural and environmental factors (Shafii, 1999: 85). In researches based on the perception of the blind and non-blind people, the detection of space is defined by the distance. In micro-scale spaces, identification is done by touching and hand movement. In large scales, it needs movement and the self-orientation of the body is less reliable. The location of objects can also be determined in two ways: the distance of the body to the object or the distance of the object to the other object. Blind people, those who are blind from the birthday, determine the distance or location of objects through its distance with their body (Sultani Gharaii, 2017: 36).

The architectural space around the human is surrounded by various elements and components, such as the natural and artificial elements. In understanding some of the architectural components and elements, the use of echo-based orientation may emphasize on the perceptions resulting from other human perceptual systems; therefore, it does not provide a reliable answer by itself. For example, in open spaces, skin sensations and, perhaps, smelling sense can completely perceive the green space, and at this time the use of echo based orientation may signal the barriers for the blind people. However, regarding the gender and other features, if other perceptual systems are being used, the result will be far more desirable and reliable (Amrollahi and Soltanzadeh, 2016: 8).

6.1. Mental Image in the Blind People

Concerning the mental visualization, researchers have concluded that based on human perceptions of the environment; there are two main types of visualization: visual mental visualization and verbal auditory visualization. Visual mental visualization is saved in an objective form and verbal auditory visualization is saved in abstract and mysterious way. The first one is formed at once and the latter is formed gradually (Shafii and Sharifi Daramadi, 2006: 130).

Mental visualization shapes human actions. These images are made up of more detailed mental images and their combination form the simultaneous action of the human being, the planning of moving to different locations, the tasks and the way of feeling the environment. If these partial mental images overlap, they reinforce each other; otherwise one dominated another (Shafii, 1999: 134). About the sensory basis of subjective visualization for the blind and non-blind people, we can say that for non-blind people, sight and touch perception, and for the blind people, auditory perception is important. Since the mental image is a kind of cognitive information, it is very effective in improving the blind people communication with the environment. Careful attention should be paid to designing and planning the functional space for the blind people (Sultani Gharaii, 2017: 37).

6.2. Environmental and Urban Space Perceptions in the Blind People

There is also a fundamental difference in the scope of non-blind and blind people visibility due to their instrumental differences in perception of space and the confrontation with the environment, namely the lack of sight, which is considered to be a main condition in mobility and access to space. Space detection scope is a range that the blind people can understand with the help of senses. Although this range is slightly different and often lower than that of the non-blind people, it is qualitatively in higher level and includes a more extensive range of information (Farzin and Shebani, 2010: 64). Since space measurement among the non-blind people mainly depends on the sight sense and the role of other senses is low and also in this situation, a higher level of information is received, and the subject matter can be revised at any given moment, they do not require storing the information in the memory. They do not need to perceive space accurately and permanently because at any given moment they can obtain information about it. However, the blind people have to perceive their surroundings by other senses only because of their lack of sight or its severe weakness. What the blind people receive at any given moment from the environment is limited information and is completely dependent on the time and the place in which he/she is located (Nadaf fard, 2000: 129).

Although the sight sense is the most dominant one, the urban environment is not felt only in this way. Awareness from the aspects of the environmental perception, attention to it and especially perception and experience of location is one of the important aspects of urban design and has been studied since the early 1960s. Through walking, our body deeply connects with the environment. Inevitably, through using all senses, including touch, auditory, and audio senses, except sight, responds to many sensory stimuli in the urban environment. Giving these points and knowing that many blind and visually impaired people are able to recognize some colors and light, we find that the key perceptual elements for the blind and visually impaired people are choosing the right materials which are in harmony with their characteristics, the sounds in The city, urban furniture and their colors and proper lighting in urban spaces. Attention to the aforementioned cases in urban spaces is an essential factor in the orientation and not confusion in the city (Sultani Gharaii, 2017: 42).

7. Educating Architecture for the Blind Students

It is clear that the architecture of traditional contexts, instead of the visual and mental domination, is necessarily linked to the perceptual knowledge of the body. Construction in traditional cultures is driven by the body, just as the bird forms its nest by moving its body. It seems that local clay architecture is mainly a product of touch and muscle, not sight, in most parts of the

world (Bechelard, 2009: 7). Attention to individual talents and differences in processes and human affairs has been affirmed and emphasized by Islam. We can say that Islam seeks to emphasize the components so that each component locates in its own place, grows to its full potential, and attains excellence. The aim is to achieve God's favor, the growth and excellence of human being, and all things related to him as the highest Creature. This effort reaches the unity at the highest stage; a unity that is different from solidarity and enjoys from plurality. The components are different and are not generalized through their similarities, but are made clear through differences and attain unity (Eslami and Sadeghi, 2013: 87). Understanding students is one of the most important factors affecting education in architecture workshops. An architecture student cannot be trained and educated under a pre-arranged schedule without a thorough understanding of his reactions to the data and demands. One way of understanding this is paying attention to learning styles which express learning preferences and differences among individuals. Coordinating teachers' teaching methods with students learning styles will enhance learning ability and academic achievement; Hence, due to the increasing number of applications in diverse scientific and skill areas and the different characteristics of the students in understanding and processing learning contents, there is a rapid need for learning the characteristics of learners in different disciplines including architecture (Feizi and Dejpasand, 2018: 149). Learning styles have been defined as the differences between individuals in the learning. In fact, learning styles can be described as different ways in which people organize and process information and new experiences in the mind (Khandaghi and Rajaii, 2013: 22). Therefore, teachers need to create an environment in which different needs of learners and, consequently, different learning styles are taken into account in order to incorporate and use them in their teaching. It can improve academic achievement, deeper learning, and more effective education (Feizi and Dejpasand, 2018: 150).

7.1. The Process of Understanding and Processing Information

Disregarding the understanding and processing of the information that can occur in a variety of ways made the capable and creative students unaware of some of their latent potential, or they view them as contrary to the class methods that may ultimately frustrate them. Thus, it is seen that architecture students are less likely to go beyond mere and superficial learning and find education that will enable them to solve their past education, including facing real work and life issues (Frazyian and Karbassi, 2014: 89).

7.2. Experience-Based Training

The new approach in learning is consistent with the meaning and concept of learning, in which education means re-building or revising experiences and re-forming them in order to better grow. The reflection on educational psychology shows that its theories calls for objective observation, learners' practical participation, or in other words, experiencing and performing them as an important part of the learning process (Frazyian and Karbassi, 2014: 88). Referring to existing examples and works and generally objective experiences in architecture, as a strategy to increase the practical ability of architects in architectural design, although seems a familiar subject in the field of architectural education, in practice, it is accompanied by some doubts, so that in designing workshops, the scope of using this strategy varied from an effective strategy to an inconsistent creativity approach. Although accepting or rejecting each of these approaches has solely been based on rejecting or endorsing intellectual and philosophical attitudes such as modernism and

traditionalism, we cannot ignore the place and function of instances and experiences in process of designing and promoting practical knowledge of architecture (Mirjani, 2010: 4).

7.3. Teaching the Blind Students

A number of students who enter college each year have special needs. One of those groups is the blind students. Partially blinded or semi- blinded people can use their sight ability in learning and use books with bold lines or devices having enlarge lines (Kakavand, 2009: 74). Blind students are eager to use their hands in the learning process and use computer and calculators to learn. That is why the students who are visually impaired have a particular style of learning that root in their unique perception of the world. Visual information of a blind person relies on hearing symbols, verbal communication or information resulting from challenging environments, so they have difficulty in building the whole scene, while the non- blinded people incorporate the features into the concept by constructing an abstract concept of an object. For example, there are many different birds that the blind people can classify them as birds because they have an abstract concept of the bird. Blind people evaluate the objects with a sense of touch and it is difficult for them to image the pictures; In fact, their ability to use abstract concepts based on visual information depends on their sight level. Another issue that concerns the learning style of blind students is the time needed to collect and process the information. Equally, information acquisition is slower and limited than visual acquisition (Peterson et al., 2009: 520). Therefore, to teach the blind students, different styles should be considered compared with other people; it is obvious that proper education and learning can make a huge difference in their lives.

8. The Role of Education in the Blind Student's Perception of Architectural Space

Based on the above mentioned points, it can be concluded that individual characteristics and physical conditions play an important role in the education of people, so proper and appropriate education of the individual can influence his/her feelings and perceptions.

Teaching space perception to students in both theoretical and practical forms has been conducted by the architecture teachers. In the theoretical aspect, there was an emphasis on highlighting what constitutes the human (semantic) and physical (material) aspects, and in the practical form, the students experienced being in different types of space. This is done by modeling, simulating, visiting different spaces using different expressive tools. The main difference between the teaching methods was in the practical aspect of education, which has a greater impact on the formation of the student's perception (Moazami, 2011: 64). Therefore, it can be concluded that in teaching perception of space, the learner must directly interact with the spaces. This is made possible by the professors and according to the situation of the individuals, as a result of which they got a different understanding of space and this can bring much comfort to the social and individual life of the students.

9. Research Hypotheses

The research hypotheses are formulated as follows:

A) Through the basic architectural training, the level of spatial perception of the blind students can be improved.

B) In terms of the spatial perception level of the blind students, there is a significant difference between people who have been trained in architecture and those who have not been trained.

10. Testing Hypotheses

In order to test these hypotheses through experimental method, in Tabriz Basir Cultural and Art Institute, introductory classes of architectural education were held for the blind students with the informed consent of all participants. The statistical population includes the students of this institute who were 15 male students with total blindness. Initially, a pre-test with 10 questions was conducted without having any architectural background. Then, an introductory architecture course including topics coded by the Ministry of Science was held. After the course, another test similar to the pre-test was held, and the results of these two tests were evaluated and rated by the professors and reviewers selected by the authors. Finally, the results of these two tests were analyzed for the final conclusions. In the following, we examine the three main sections of the study, including pre-training, training, and post-training for the study group, and provide the results.

10.1. Pre-Training

Before starting the training of the blind students and to better examine the impact of this learning, ten questions were asked by the authors. They were explored through introductory chapters of architectural education and with a greater emphasis on the perception of architecture and urban space. Since the space measurement in the normal people is done by over-reliance on vision and the role of other senses is low, also considering this fact that the sense vision gives higher levels of information and the subject can be reassessed at any given moment, a normal person requires less information to be stored in memory. Therefore, the normal person does not need to perceive space accurately and permanently because he/she can obtain information at any given moment, while the blind students only have to perceive their surroundings by other senses only due to their lack of vision or severe weakness in this sense. Then, what the blind students can acquire at any given moment from the environment is limited information and it is completely dependent on the time and place. He/she has to perceive the space through putting together the information gathered by other senses (Nadaf fard, 2000: 129). For this reason, it was attempted to select questions considering some points like understanding the surface and volume of spatial memory of the research community in order to understand how their spatial understanding and take further measurements with regard to this function.

After collecting the answers from the respondents, they were analyzed and reviewed by the professors and referees approved by the Ministry of Science and selected by the authors, and each response were rated (very good, good, average, weak and very weak). The ten questions are as follows:

Table 2 Pre-training test of the blind students

No.	Question	Research Goals	Mean	Result
1	Drawing lines; parallel lines, symmetrical lines, two perpendicular lines	Surface Perception: Surface in the blind people is considered as the boundary between spaces and functions and can be used as an indicator of location, path and direction. Since the fact that wall is also a distinguishing boundary in the normal people and the wall is a base in architecture, the practical value of the wall becomes	1.9	weak
2	Drawing shapes; squares, triangles, rectangles and circles		1.8	weak

		much more evident in the perception of space. Due to the lack of vision in the blind people, the wall must be equipped with some means (Farzin and Sheibani, 2010: 64).		
3	Drawing the lines of the room where you are	Understanding the edges and corners: Corners show the end of a path, a position, or an extension (D.K. Ching, 1989: 44). Due to the use of the wall as a help parameter by the blind people in understanding the location, these edges and corners are of particular importance in terms of architectural perception and design.	2.1	weak
4	Drawing the outline plan of the house in which you live		1.8	weak
5	Drawing lines of the park in which you walked		1.9	weak
6	Touching a mass and then drawing it without revising	Mass perception: The basis of architectural mass and its perception through form and its functions are: shape, size, color, texture, location, direction and visual balance (D.K. Ching, 1989: 44). However, it is possible to understand most of these items through visual skills. Of course, with a clear definition of these principles for the blind people, their understanding may be somehow better.	2.7	Medium
7	Constructing geometrical masses including pyramid, cube, etc using 3D pen and clay		1.9	Weak
8	Drawing three facets of a mass		1	Very weak
9	Drawing facade of a building	Spatial memory: Blind people emphasize on understanding space through movement and understanding time and space distances, but not by linear range, and they also emphasize on the effect of air type and ambient noise differences on sound volume and influence of airflow in space without hitting the around and without cane help (Farzin and Sheibani, 2010: 65)	1	Very weak
10	Drawing the lines of a place where you were in for the first time.		1	Very weak

As it can be seen in the table above, without any mental background and training related to architecture and space perception, level and volume of perception and edges and corners in this group are poor and the spatial memory of this group is very weak.

After presenting the questions and assessing the answers and examining the results, the following chart was obtained by analyzing the average score of each question from 15 students:

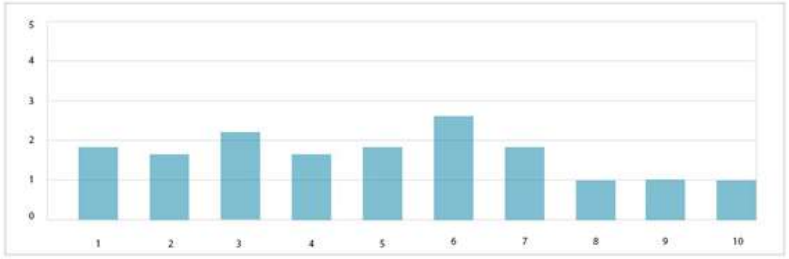


Fig 1 Average test scores before training the blind students

10.2. Basic Architecture Training for the Blind Students

After selecting the statistical population among the students of Tabriz Basir Institute and taking a basic test of them, the basic topics in architecture were taught. These topics were selected by reviewing the introductory courses of the Ministry of Science and approved by the professors of Islamic Azad University of Tabriz. The authors tried the trained subjects have conceptual relationship with spatial perception. Before training, some tools and supplies needed to teach the blind students were provided for the classes.

The discussed trainings included the following methods:

A) Training through physical representation of the topics and practical exercises: This method enhances the practical skills of the learners by representing the topics in practical forms and their repetition by the trainer. It is mostly used after theoretical trainings and for preparing trainees to practice (Saghafi et al., 2015: 381).

B) Training through academic expression: In this method, the educator describes the practical application of a scientific topic to the learner. Because of dealing with the power of imagination and visualization, it is more widely used in the architecture and its advantages can be used to train these powers in the architecture learners (Ramaswami, 2001: 165).

C) Training through Professor and Student method: learning the needed skills by observing, imitating, and approaching a master; trying to create the appropriate situation for the emergence of innate talents and human evolution, and consequently the acquisition of crafts (Mahdavipour, 2012: 25).

The topics presented during the training sessions, goals and results are summarized in Table 3:

Table 3 Basic architecture training for the blind students

Session	Subject	Goals	Topic reference
First	Introducing the topic, being familiar with tools, general familiarity with architecture and environmental perception	Being familiar with the art students and introducing architecture and its role in the perception of space	Basics of Architecture Design (1), BSc of Architecture Course: Since the topics discussed in Architectural Design include both the material (skill) and conceptual (intellectual) fields, and given that familiarity with the material areas (skill and practical aspects) is the basis for dealing with the conceptual fields of architecture, the introductory course in architectural design further develops skills and techniques that provides context for rich conceptual arenas.
Second	Being Familiar with understanding and expression of architecture, acquaintance with regular and irregular masses, acquaintance with point concept, acquaintance with line and surface	Familiarity with the basics of the present forms found in the nature or human environment	
Third	Increased spatial perception of the architectural environment	Increased spatial perception of the architectural environment	
Fourth	Being Familiar with the physical elements of a building, outdoor and indoor, private, semi-private and public areas	Increase spatial perception and actual visualization of buildings with different functions	
Fifth	Repeating and expanding the masses and spatial understanding of the resulting masses, and visualizing and perceiving the	Increasing the perception through touching sense	

	masses through touching		
Sixth	Being familiar with the scale, Drawing Similar Shapes with Different Scales, Drawing Shapes and Transitions and their rotation	Basic introduction to the simple concepts of visualizing and drawing space from an architectural perspective	
Seventh	Practical introduction to some of the most commonly used materials, familiarity with modeling tools	Increasing real understanding and visualization of the living place	
Eighth	Practical and experimental construction with building materials	Understanding the basics of building architecture	
Ninth	Training the way of drawing their room or space with a point, line and page	Getting a perceptive response from students about the space in which they are located	Basics of Architecture Design (2), BSc of Architecture Course: In this course, the students are introduced to the conceptual problem of architecture and its understanding, expression, criticism, and application in design.
Tenth	Acquiring the intrinsic ability to perceive, visualize, and capture the masses	Increasing the ability to visualize and imagine	

(Reference: Ministry of Culture and Higher Education Planning Board Index; Announced to the universities and professors)

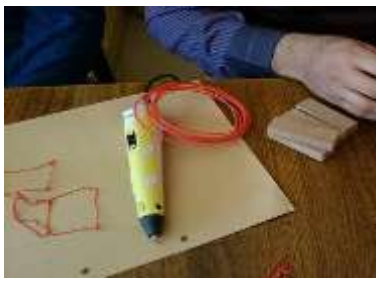
10.3. Tools used for Education

To teach the blind students, as mentioned above, attention to the physical condition and abilities of the blind person is one of the most important things. To do this, recognition of required tools seems crucial. In this study, the authors also examined the necessary tools and then provided them. The tools used in this study can be categorized into three sections: Educational tools for the blind students, Architectural training tools and tools for architectural space perception; these three sections will be discussed in the following.

a) Educational Tools for the Blind Students

There are a variety of special tools available for teaching the blind students that are more concerned with touch sense; For example, the 3D pen is used to draw 3D lines. This pen works using a light source and element and makes the liquid through heating polymeric material and after drawing being in the open air; It quickly dries and creates lines. Account Tablet is another tool used by the blind students for teaching the mathematics. Braille paper is a tool for the blind students to read and write. The Table 4 summarizes the basic tools used for teaching the blind people along with educational goals and their associated images.

Table 4 Educational tools for the blind students

No.	Training tools	Goals	Photo
1	3-D Pen	Understanding the space and mass through touching	
2	Game cubes	Designing and understanding space in three dimensions	
3	Clay	Drawing and understanding drawings through touch sense	
4	Account Tablet	Understanding the Scale and drawing through the scale	
5	Braille paper	Use training tool for the blind students for drawing and understanding the lines	

(Reference: Based on Special Education Organization Index; Announced to special education schools)

b) Architectural Training Tools

The primary tools for architectural training that were implemented by the study group after using the specific blind student's tools, were pencils, rapids, markers, rulers and various templates. Putting away the basic tools required especially for the blind students need the leaning of other tools before. After learning the way of using these tools, the study groups were able to use them and like other students they could understand the architectural environment.

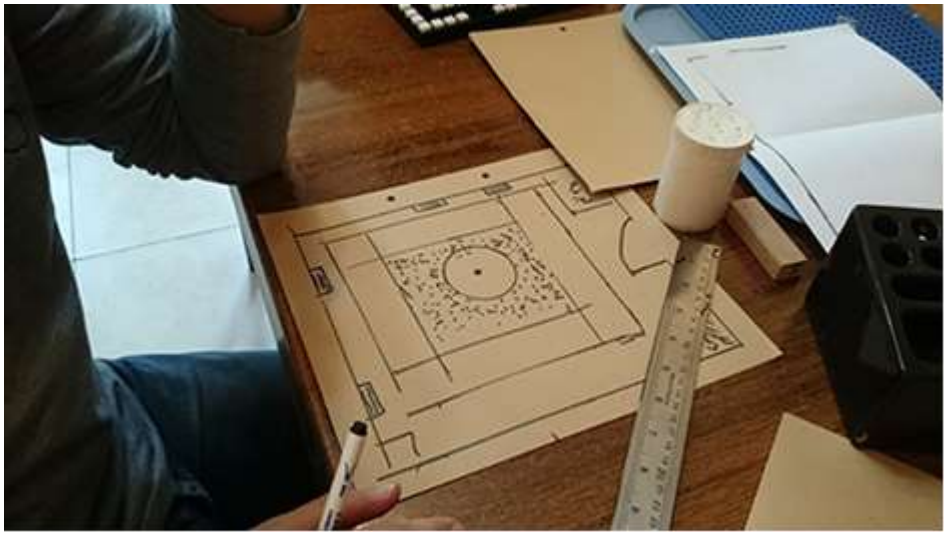


Fig 2 Blind students using architectural training tools such as ruler and marker

c) Tools for Architectural Space Perception

The training tools were prepared based on the syllabus of the curriculum and designed by the authors and provided through techniques such as laser cutting and 3D printing. In designing these tools, aimed to that the study group identify the various architectural spatial elements through touch sense and finally they can also design and build them by themselves.

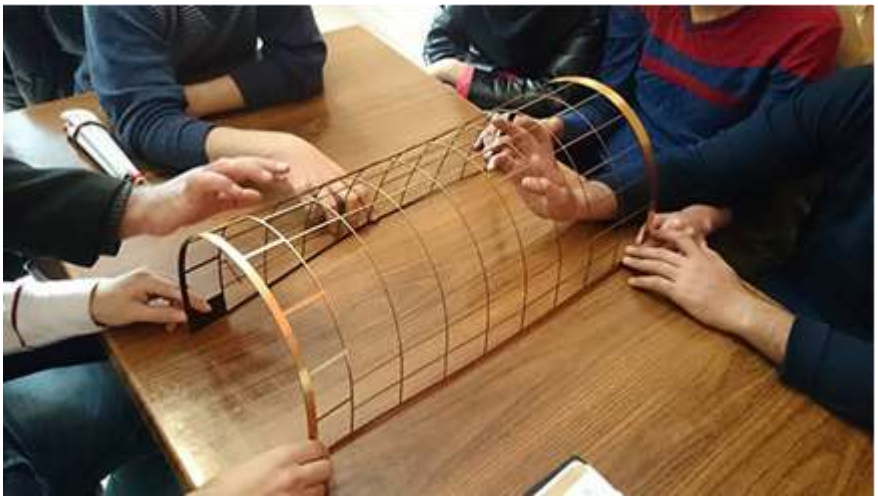


Fig 3 Arch training in architecture to students through the tools provided by laser cutting

10.4. After Training

After examining the subjects and following the educational process and examining the results and comparing them with the results of the previous test and the final conclusion, another test was carried out.

Spatial indices for the blind people appear to be similar to those with normal people, but they differ in functional form (Amrollahi and Soltanzadeh, 2016: 9). In this section, the authors attempt to analyze these spatial indices and the role of architectural education on their perceptions. The grades given to the questions were used by the professors in the pre-test exam and it was attempted to consider the grades listed in the index of the Ministry of Culture and Higher Education Planning Board.

This test had ten questions like the first test. The selected questions were slightly more advanced and we attempted to measure the spatial perception of the study group. The ten selected questions included:

Table 5 Testing after the primary training of the Study Group

No	Question	Research Goals	Score mean	Result
1	Drawing the address of the institution and identifying neighboring uses	Mobility and Orientation in the Blind People: Mobility is the ability to move safely through space without having to know where the blind is and what purpose he/she has. That is why mobility is considered as aimless activity. But if the topic of orientation is added, mobility will become a useful and purposeful activity. Spatial orientation is defined by John Lang in his book "Romedi Pasini" as "The ability to express the position in the environment through cognitive roles" (Amrollahi and Soltanzadeh, 2016: 10).	3.7	Good
2	Drawing communication paths from urban centers close to the institution and identifying existing barriers		3.3	Medium
3	Analysis of a selected site; Including wind analysis, sun movement, annoying noises and views of the site		3.7	Good
4	Designing and drawing 3D masses by specifying at least one user for per mass	Mental Imagination: In general, imagination is the mental representation of an absent object or approach; this is a general definition that includes both visual mental images and images formed through other senses (Sharifi Daramadi, 2000: 25).	3	Medium
5	Making the masses designed with tools like 3D pen and clay		3.2	Medium
6	Identify the private, semi-private and public spaces at the site of the institution	Relationship Between Architectural Space and the Blind People: Non-visual communication with space requires attention to other senses including sense of touch, hearing, smell, taste, sense of balance and sense of gravity; Therefore, in relation to the spatial perception of the blind one should use the relationship between these senses and the architectural space (Amrollahi and Soltanzadeh, 2016: 15).	3.4	Medium
7	A visual description of a hospital or medical center that was used before		3.3	Medium

8	Designing and drawing plans for a study room through determining the openings and skylights	Blind People's Perception of the Basic Elements of Space: The basic elements of space in the perceptual and emotional structure of the blind include surface, volume, edges, and the paths (Farzin and Sheibani, 2010: 65).	2.7	Medium
9	Designing and drawing the plan of a guard room through locating the required spaces		2.3	Weak
10	Designing the shadows for windows in different places of the institute by examining the skylights		3	Medium

As can be seen in the table above, after the basic training of architecture to the subjects, good mobility and orientation was in acceptable level and the mental imagination, spatial communication, and perception of key elements of space increased to a moderate level.

After presenting the designed questions and measuring the answers and results, the following chart was obtained through the analysis of the mean score of each question.

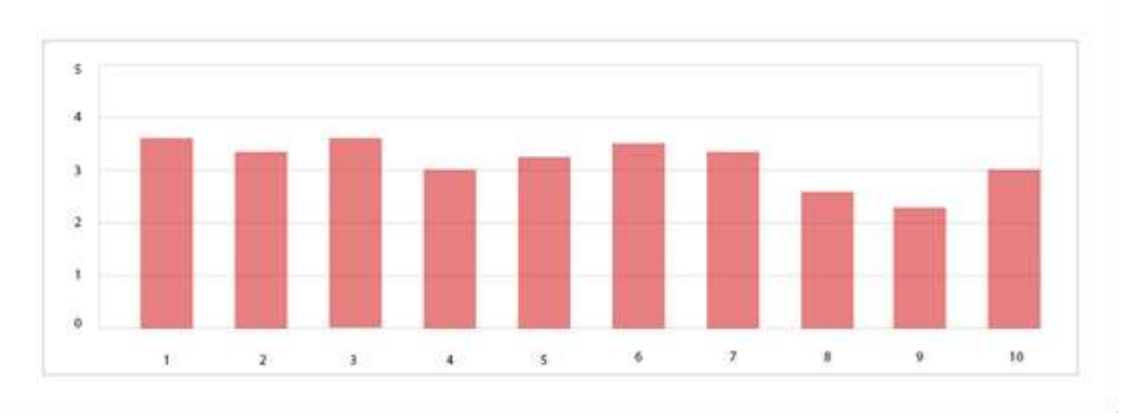


Fig 4 Average test scores after training the blind students

In examining this test and comparing it with the pre-training test, significant improvements in spatial and architectural perceptions of the research community were observed. Following the qualitative analysis, we will continue to analyze the statistics obtained from quantitative method.

11. Assessing the Normality of the Distribution of Variables

Shapiro-Wilk[†] test was used to check the normality of the variables. The null hypothesis in this test is that the distribution is normal. If the significance level of the test is more than 0.05, the null hypothesis is verified and we conclude that the distribution of the desired variable is normal. Considering the significant levels of the variables, it is concluded that the variables have a normal distribution (significance level greater than 0.05).

[†] The Shapiro–Wilk test is a test of normality in frequentist statistics.

Table 6 Testing normality of variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Before training	.159	15	.200*	.958	15	.657
After training	.139	15	.200*	.958	15	.652

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

11.1. Comparing the Scores Before and After Training

Here, paired t-test was used. In this test, the null hypothesis says that the mean of pre-training is equal with post-training mean. If the significance level of the test is less than 0.05, the null hypothesis will be rejected. Mean scores of pre training was 16.93 and mean of post training was 32.13. The significant level was 0.001. Given the significance level of the t-test which is less than 0.05, the null hypothesis is rejected. As a result, the scores of post-training were significantly higher than the pre-training scores.

Table 7 Comparing the scores before and after training by T-test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before training	16.93	15	3.327	.859
	After training	32.13	15	8.026	2.072

Paired samples test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Before training After training	-15.200	5.634	1.455	-18.320	-12.080	-10.449	14	.000

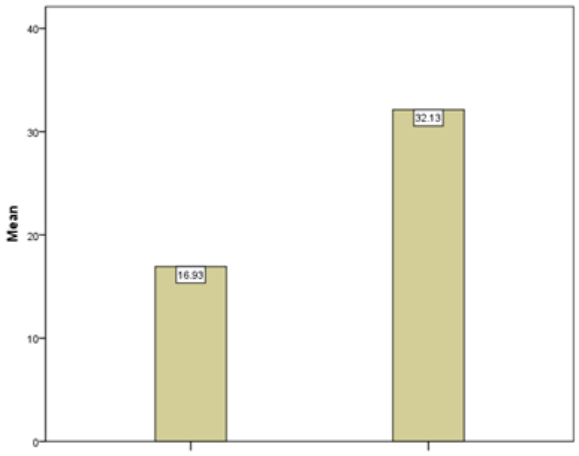


Fig 5 Comparison of pre- and post-test scores based on T-test

12. Research Results

Based on the presented research and examining pre- and post-test scores, and by analyzing the comparative chart below, it can first be assumed that basic architecture training has a significant impact on spatial and environmental perception of the blind students.

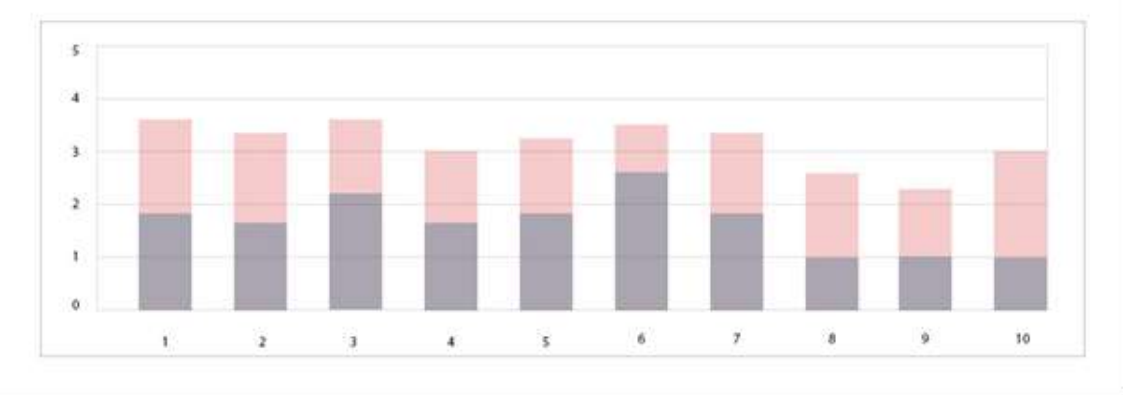


Fig 6 Comparison of pre- training (dark colors) and post training (light colors) mean scores

Theoretically and practically and for enhancing the quality of life of the subjects, and also for appropriate understanding of the environment, one can first use the abilities of individuals for their participation in designing and creating space. The quantitative and qualitative results of research can lead to the development of methods for better understanding of the universe and creating the architectural spaces for all classes of society. They can be formulated based on the new and emerging standards in this regard. The findings of the research can be used in various fields such as architectural education, blind education, architectural design and urban design.

The results of this study can also be examined from several perspectives:

Cultural dimension: By educating and enhancing the architectural perception of the blind people, the presence and impact of this group on society can be enhanced in cultural affairs.

Social dimension: The presence and effective role of the blind people in society and a better understanding of the world and the creation of appropriate social spaces for all groups of society.

Psychological dimension: Increasing the self-confidence and utilizing people's abilities for their participation in appropriate designing in order to achieve comfort and prosperity in life.

Artistic dimension: Revealing other horizons of perceptual and creative aspects that are based on senses other than the sense of vision.

Humanistic dimension: Improving the life quality of blind people in society.

Based on this research, the following points can also be explained directly or indirectly as part of the results:

1. The results of pre- and post-training tests, both by examining the mean scores (qualitative) by the teachers and also by examining the t- test (quantitative) results, show that teaching architecture to the blind students increases their space perception.

2. Recognizing the student's physical abilities and disabilities, exploring the tools needed for better learning and trying to use the tools appropriate for the physical conditions, improves the teaching process and enhances the quality of learning.

3. Education, regardless of physical condition, can lead a person to a new understanding, which in many cases can improve their living conditions and reduce the problems.

4. By educating the blind students, not only they can understand their surroundings better, but also it helps us to understand the problems of this group and seek to improve their life quality.

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