

Educational Space Design Principles; with an Approach to Improving the Performance of Children with "Learning Disorder"*

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ABSTRACT

A learning disorder is one of the prevalent problems during childhood, which is usually diagnosed during school years although is diagnosable in pre-school ages. This disorder causes some education problems, such as weak academic performance, being rejected, and even dropping out of school resulting in the incompatibility of these students in the school and disorder in the education process. If this disorder is controlled during childhood, the irreversible damage in adulthood will be minimized. Regarding the effect of the environment's role on human behavior, this research asks what are properties of a standard educational space are for improving the performance of children who suffer from learning disorders. This study aims to explain the design principles of educational environments or settings to improve the performance of children with learning disorders. This is applied research with a selected descriptive-survey research method. Findings indicate that because children with learning disorders have different needs based on their disabilities, the schools must provide a set of educational places that meet the various needs of these students. Seven general models (normal classroom model, consultation model, mobile model, reference room, special classroom, separate day school, and boarding schools) have been proposed for the educational space of children with learning disorders. The result of this study comprises a set of principles for the design of educational settings that have been classified based on their effects on the improvement of performance among children with different types of learning disorders (dyscalculia, dyslexia, and dysgraphia, as well as the shared characteristics of these three disorders). The results of this study show that architectural qualities (form quality, qualities related to light and color, sound qualities, functional quality, layout, and furniture qualities, design qualities based on the perception and sense related to nature, security quality, and psychological peace of space) would promote performance of children with learning disorder.

Keywords: Learning Disorder, Child, Architectural Design, Educational Space.

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1. INTRODUCTION

Unfortunately, many disorders during childhood and adolescence are learning disorders. Learning disorder is a general term that includes serious problems in reading, writing, reasoning, or mathematics. These problems are not caused by mental retardation, behavioral disorder, and sensory deficits (MirMehdi 2007). These children have a normal appearance and their intelligence (IQ) sometimes is normal and higher than normal children but they are not identified before they start school. When they enter school, their difficulties in reading, writing, and calculating gradually appear. When facing consecutive academic failures, these children suffer from emotional disturbances and antisocial behaviors that cause other problems (Nikkho and Ovadis Yans 2002). The weak performance of these students may affect their mental health indicating itself in most psychological problems, including anxiety (Ashouri, Jalil Abkenar, and Ashouri 2013). Since this disorder may remain until adulthood for a long period, it must receive more attention. Learning disorders are not synonyms with other terms such as compensatory reading or late learning. This definition particularly refers to those children and adolescents that severely suffer from specific learning disabilities. Students with this disorder need special education, so professionals believe that this education must provide special, uncommon, and qualified non-normal practices and training. This education technique is beyond the regular educational techniques used for the majority of children. Professionals are responsible to cover the special learning disability of the child in the frame of individual education or small groups. Some factors may affect this disorder, including educational, environmental, mental factors, and genetic, while the previous and present experiences indicate that learning disorder is an interdisciplinary concept, so the link between experts and professionals of different scopes must be kept (Edward 1997).

Some education science studies have found the effect of environment on children's learning disorders, introducing improper living space as a factor that develops this disorder. Researchers believe that environmental factors that influence the behaviors of children with disability have not been studied enough. They also assume that the surrounding environment of the child affects the development of behaviors arising from the disorder. The difference between the environmental setting and social space of children is logical, so studies must apply the mental-social procurements, such as training parents and creating suitable environments for the children to create interaction between the child and the environment. Interdisciplinary studies in the space design field have been done on other disorders, such as hyperactivity, depression, and so forth. These studies have confirmed the positive effect of the environment on preventing or treating these diseases. However, no study has

been done on children with learning disorders, so a research gap exists in this case implying the necessity of doing the present study.

Psychology and educational science studies are just theoretical, while an interdisciplinary study of architecture-educational science regarding the connection between architecture and other disciplines- can determine the required measures to prevent and treat this disorder. Architecture can use strategies and measures of other disciplines using them to build the human setting (Wang and Grotton 2002). The built environments can create, strengthen or weaken some behaviors. This study tries to determine the architectural features of the educational environment of children with learning disorders. The results extracted from this paper that introduce and determine some important properties of the educational spaces for children with learning disorders can be directly used in architecture design to solve the individual and social problems caused by lack of treatment for such children. Suitable planning and design of educational setting help to prevent some crises such as depression, rejection, and social isolation threatening children with learning disorders by spending low cost, short time, and less energy.

This paper has five sections. After examining the research method (section 2) and literature (section 3), the characteristics of children with learning disorders are examined based on the disorders related to reading (dyslexia), writing (dysgraphia), calculation (dyscalculia), and common characteristics. The discussion is continued by classifying interventional factors and their specific educational space affecting the improvement of children's performance. The models of schools' services and their advantages or disadvantages are presented. Since children with learning disorders have different needs based on their disabilities, schools must provide educational places that meet the needs of these students suggesting better services. The research results determine the design principles affecting the children with learning disorders based on the disorder type and the qualities that improve their performances (Section 4), and finally, the conclusions are expressed (Section 5).

2. METHOD

This is applied research in which, the descriptive survey method is used. After data were collected through questionnaires, interviews, and library references, a factor analysis technique was used to extract and determine the most important effective variables. The research hypotheses were then tested and their accuracy was studied using the correlation method based on the relationship between mentioned variables. The data were gathered based on the Delphi Technique (experts' opinions) in this paper. In this research, each hypothesis has been assessed in terms of its attitude based on the opinion of experts

in educational science, psychology, and architecture. Descriptive and inferential statistics are used in data analysis and hypothesis testing stages. The research phases are done within the following four steps:

Step 1: the semi-structured interview (using open-ended questions) with psychologists in the learning disorder field

Step 2: attitude assessment of educational science and psychology experts to confirm the findings of step 1 (using closed-ended questions)

Step 3: attitude assessment of architecture experts to find architectural principles

Step 4: analysis and conclusions, and determining the design principles and relevant criteria¹.

3. BACKGROUND

The background of this study can be reviewed within two subjects. The first part includes the background of definitions and factors affecting learning disorders in educational sciences and psychology. Many studies have been done in this field, including a study titled "Comparison of social skills of students with learning disabilities and normal students" that indicated the social skills of students with learning disabilities are weaker than other students (Kashmiri 2018). Various studies indicate that students with a non-verbal learning disability have disorders in social information processing (Bauminger and Kimhi Kind 2008) and interpersonal skills (Ladd and Troop Gordon 2003; Wiener 2004) suffering from high-level social rejection and loneliness. Social skills-related problems, such as cooperation, assertion, asking for help, and admiring others are some of the problems among individuals with a non-verbal learning disability (Greshman and Elliott 1999). One of the characteristics of children with non-verbal learning disabilities is a lack of understanding of non-verbal communication, many defects in judgment and social communication, and a lack of understanding of conflicts and humor based on age. These children have problems understanding the face modes, voice tone, and body language, which causes difficulty in making social relationships. Non-verbal learning disorder leads to social inefficiency making it difficult to deal with new situations. This issue is a risky factor for depression and suicide probability due to social isolation (Gorman 2001). Those children that have specific learning defects have lower social positions given their peers and classmates, so they are rejected by their peers (Vaughn and Sinagub 1998). Learning disorders cause many undeniable problems for these children, while no study has been done to consider the role of educational settings in improving this disorder. The second category of studies includes those researches that examine the role of architecture's physical setting on human behavior (Rappaport 1982; 2005; Mortazavi 1998; Moore, Sugiyama, and O'Donnell 2006). Modern architects and urban planners try

to create a logical link between structure and the environment. They study the components affecting the human-natural environment communication in the physical setting regardless of some ideas, such as building coordination and respect for nature, the sociability of physical and natural settings, and paying attention to climate, culture, and beliefs of the users (Daneshgarmoghaddam, Bahrainy, and Einifar 2011). Some educational sciences studies have found the effect of environment and setting on children with learning disorders considering improper living space as the factor developing this disorder in some cases. Harkness et al. believe that the environmental factors influencing the behaviors of children with disability have not been fully examined. They assume that the environment, where children live would affect the development of disorder-caused behaviors. The educational environment and social space of children are different, so it is better to consider social-mental contexts, such as parent's training, and "creating suitable environments for children to make the relationship between child and environment" (Parens and Johnston 2008). Interdisciplinary studies have been done on the space design for other disorders hyperactivity, depression, etc. that have confirmed the positive effect of the environment on the prevention or treatment of these diseases (Azhdehfar, Azhdehfar, and Omrani Pour 2013). Few studies have considered children with learning disorders, so further studies are required for this subject, which indicated the necessity for conducting the extant study. This study asks how can create an environment based on the needs and effective properties in treating children with learning disabilities to nurture them in an appropriate platform. The purpose of this study is to take valuable steps based on the topics raised from behavioral sciences to increase and improve the spatial qualities in such environments. Acceptable results also must be achieved regarding the underlying properties in this case.

4. RESULTS AND DISCUSSION

According to the impact of the physical environment or setting on the improvement of performance among children with a learning disorder, this study aims to find suitable design principles for educational spaces where the child spends a long time.

Before finding the proper design principles, it is essential to identify common disorders of children with learning disorders, as well as disorders related to calculation, reading, and writing skills. Moreover, when the interventional factors affecting the improvement or treatment of children's performance can be an effective step to identify their need for appropriate architectural space. This study reports the disorders and suggestions for improving performance and suitable architectural space for each disorder in four tables.

Table 1. Treating Reading Disorders (Dyslexia)

Final Goal	Specification	Interventional Factors	Environmental Solution
Treating Reading Disorders (Dyslexia)	The impaired vision understanding and memory (difficulty in rapid understanding of letters and words)	Watching clouds and telling stories about them, and performing pantomime (Tabrizi 2014)	Using the capacity of lights and colors in interior design: an environment full of lighting with different colors, use of various colors, using Persian carpet, and floor covering with various colors
	Verbal language problems, such as difficulty in speaking	Telling a joke or story (Tabrizi 2014), an improvement for students when is speaking using a speaker and TV craft	Design the scene of the show and stage for the story, different setting designs to encourage students to speak and play the role of speaker and sound echo
	Impairment in word expansion	Telling stories (Tabrizi 2014), using reminders, color, and image (visual memory), repeating words in front of the mirror, using applications and games	Using mirrors in interior design, using smart banners in classes, and installing relevant games and applications for words expansion
	Delay in lingual growth	Jumping on both legs on two sides of a rope, hopscotching, telling jokes and stories, swinging front, back, left, and right, and rotating, laying, and rolling on an ivory plastic ball (Tabrizi 2014)	Design a gym or playground equipped with sports devices, such as gym balls. Rope, etc. Providing space for sketching hopscotch on the yard ground or changing the color of cells on the gym's tatami (floor covering)
	Speech (verbal) disorders: deletes the last words, cannot tell his/her thoughts, tells unrelated topics, cannot spell the words well, has weak speech, and tells incomplete sentences.	Sound imitation, cleansing dirt on the devices by blowing, fogging the mirror by exhaling the air from the mouth (Tabrizi 2015), inflating balloons, moving balls, feathers, and cotton in different directions by blowing, holding the candle flame by a controlled blow, using a mouthpiece that requires blowing (Tabrizi 2014).	Design of class with sound insulation, and installing a mirror on the class's wall

Dyslexia is one of the learning disorders that many studies have examined without achieving any specific result. Two activities must be done to treat dyslexia. The first activity is a neuropsychological examination and doing some practices to strengthen the part of the neural, psych, and brain that play a role in reading ability. The second activity is related to the student's problems in specific reading problems in which, medical solutions can be searched through problems related to language and speech (Tabrizi 2014). Children with reading disorders have the following characteristics:

1. Impaired vision and visual memory (difficulty in rapid detection of letters and words): some children with a reading learning disorder (dyslexia) cannot detect different letters and words with their eyes, so make mistakes in similar letters (like some Persian letters: ب-پ-ع-غ-س-ش-ک-گ) (Wallace and McLaughlin 1995). If a child is grown up in a colorless environment, he/she will not have a complete visual perception like an environment that is not full of different voices and sounds causing weak hearing perception (Grutter 2011). The table has mentioned some basic practices that simulate neurons and bring some changes in dendrites, axons, and cell bodies.
2. Verbal language problems: many individuals with

learning disabilities suffer from basic infrastructural disorders. This problem appears as difficulty in listening, speaking, word expansion, lingual progress, and linguistic abilities (Tabrizi 2014). Some measures can be taken in designing the environment for children with learning disorders and treating this problem as reported in this table.

3. Lingual growth delay: growth phases are completed at specific ages, so that when a child cannot develop a growth phase at a certain age then it is diagnosed as a growth delay. In terms of speech and language, it is stated that children spend certain stages in speech and language growth worldwide.

4. Difficulties in reading occurring due to delay in lingual growth can be somewhat treated by doing the practices mentioned in the table (Wallace and McLaughlin 1995).

5. Speech (verbal) disorders: speech disorder is seen in children who delete the ending words, cannot express their thoughts, tell unrelated topics, cannot spell the word well, has weak expression, and tells incomplete sentences. The child must do some practice to understand the sounds and spell the words as well (Tabrizi 2014). These practices have been mentioned in this table.

Table 2. Treating Writing Disorders (Dysgraphia)

Final Goal	Specification	Interventional Factors	Environmental Solution
Treating Writing Disorders (Dysgraphia)	Difficulty in listening, detecting sounds, and fast recognition of letters and words	Blowing into self-made perforated plaster sculptures, making noise-maker devices (hand-made musical instruments), playing different low-volume sounds to be recognized by students, playing with cams, detecting the musical notes, using cellphone, creating noise with spool and balloon, making sound by vibrating the strings of the instrument or replica. Using tapes and recording voice on them (Tabrizi 2014)	Hearing, visual, pottery workshop, music room
	Difficulty in words expansion	Story-telling (Tabrizi 2014), using reminders, using colors and images (visual memory), repeating words in front of a mirror, using applications and games	Design of a stage for story-telling, designing a different setting for encouraging students to speak and play the role of speaker, sound echo
	Writing language problems: weak performance in writing	Tunnel game (crawling, walking on fours, and laying on the stomach) (disorder channel)	Designing a tunnel in a part of the gym
	Auditory reactions: student repeats what hears before performance or reaction. The student repeats a single question many times.	Group game in which, several students sit next to each other and the first person says a word then the second person repeats the same word then adds another word to it say it to third person, and so on (Tabrizi 2014). Group games require active hearing and concentration of students.	Sufficient space for group plays
	Difficulty in visual and auditory memory, the students are willing to forget what hear. The student always asks what she should do.	Using tablets, using a projector, puzzle games, using reminders (Lerner 1995), using metal imaging (Lerner 1995), writing words in bold shapes using play dough, carpet, sanding, and so on (Tabrizi 2014). Using tables and video puzzles and simple games to improve memory and assigning a room in the school for child's devices, planning training, using reminders, using salt plates and sandbox (Wallace and McLaughlin 1995).	Designing the class with a smart board to use games, installing a specific table for making handcrafts for the accurate spelling of letters, installing a signed locker for tools and stuff of each student
	Laco of eye-hand coordination	Using some games, such as dart, volleyball, basketball, badminton, bead spinning, walking between lines, hammering a nail, holding a glass of water, hook, and fishing, paper scissoring, carrying a bell without making noise, spinning threat around a spool, basket, and ball, bowling, shooing a target, play with ball and racket, ping pong, etc. using a flashlight to follow a target with eyes and hands (Tabrizi 2016).	Establishing a gym or playground for dart volleyball, basketball, and badminton (Tabrizi 2015).
	Dysgraphia (writing in italic form, in the right form, and irregular form)	Setting the sitting position with an accurate angle of body, hand, and paper, putting some stuff such as soft plaster, pen (different tools for illustration), portable whiteboard for students, strengthening the hand's muscles (Tabrizi 2014).	Design of the chair or bench based on the ergonomic principles to adjust the hand motions
	Writing words reversely and symmetrically	Body awareness (awareness and mental image of body), practice with a mirror, teaching directions	Installing a mirror in the special classroom

The followings are characteristics of children with dysgraphia:

1. Difficulty in listening, detecting sounds, and difficulty in detection: many children with learning

disorders have difficulty detecting the auditory difference between various words. For instance, they cannot find the difference between two words Boro (go) or Naro (Do not go) (Wallace and McLaughlin

1995). In this case, when the child is in an environment that is not rich in sounds and voices, he/she becomes weak in auditory perception. Some samples of auditory activities are expressed in Table 2.

2. Weakness in auditory memory: Students must hear the auditory drivers and listen to them, and also must be able to store and recover them or link them if required (Lerner 1995). If the classroom is ordinary and unattractive for children with learning disorders, they cannot pay attention to the lessons. Therefore, they would show some responses such as restlessness, inattention and even disrupted behaviors if their learnings are not met (Lerner 1995). The interventional factors and therapeutic solutions mentioned in the table can solve this problem.

3. Difficulty in listening, detecting sounds, and fast detection of letters and words since better learning requires stimulating all senses of the student. Therefore, the environmental stimulations for treatment and learning can perform perfectly (Tabrizi 2014). Some practices are needed to help children understand and pronounce the sounds. Some of these practices are reported in the table.

4. Difficulty in word expansion: human brain loses some cells daily due to weakening and not using them, so some practices are required to stimulate and activate these cells. Some of these practices are reported in the table (Tabrizi 2014).

5. Auditory responses: the child's ears may be insensitive and hear the sounds differently; it may not remember the said words or may have difficulty in the sequence of said words, so the child may not be able to say words in a sequence (Tabrizi 2014). Sometimes, the child repeats what he/she hears before the performance or shows the response. The child may repeat a single question again and again. Difficulty

in auditory memory appears as a willingness for forgetting what the child hears or repeatedly ask what should he/she do. some practices can be done as plays to alleviate or solve this problem (Tabrizi 2014).

6. Eyes-hand non-coordination: coordination between eyes and hands is a highly important case. If a child is bad at doing some practices with their hand due to weak hand-eye coordination, it will affect their play skills and daily routines of life causing motor and educational delays. Multi-sensory activities that involve the child will develop sensory awareness and motor skills of the child.

Come of plays and games that parents or instructors must use to improve eye-hand coordination skills are reported in the table.

7. Dysgraphia (writing in italic, right, and irregular forms)" Dysgraphia is a kind of disorder in writing language that considers the mechanical and technical aspects of writing skill. This disorder appears as bad handwriting in children with average IQs that are not motor-based (Karimi 2002). The main indicator of dysgraphia is that the writing skill of a child is less than what is expected despite their intelligence capacity and educational level (Saif Naraghi and Naderi 2011).

8. Writing in the symmetrical form: in this disorder, the child writes from left to right (In the Persian language) instead of writing from right to left. As if you are putting the paper in front of a mirror and reading it.

9. Writing in the reverse form: in this disorder, students write from right to left while their words are reversed.

10. Treatments for writing symmetrically and reversely are mentioned in the table.

Table 3. Treating Calculation Disorders (Dyscalculia)

Final Goal	Specification	Interventional Factors	Environmental Solution
Treating Calculation Disorders (Dyscalculia)	Difficulty in spatial perception (Asasch 2020)	Using some objects, such as containers and boxes that can be put into each other and the things that can be put into the containers.	Selecting a simple and quiet environment with suitable temperature (not hot and not cold) (Tabrizi 2016), using open-plan workshops periodically, designing and creating complicated and challenging spaces
	Difficulty in mathematics: problem in quantitative thinking (Esmailzadeh Roozbahani et al. 2022)	Using real or tangible and touchable objects, such as beads, peas, and beans. Counting the objects available in the space, such as chairs, tables, etc./ clay and sand dough, and weighing the objects using scales (Tabrizi 2016).	The class must be equipped with the required devices, using details of the environment to teach the quantitative concepts and counting
	Difficulty in time, space, and calculation data (Abbaspour and Faramarzi 2022).	Conveying the concepts objectively than in illustrative and symbolic methods, and using suitable auxiliary educational instruments, such as a watch, scale, etc. (Tabrizi 2016; Baradaran, Safavi Homami, and Faramarzi 2021).	The problem-solving room must be attractive and organized (Lerner 1995).

Some people that suffer from learning disabilities do not have difficulty in learning language and reading, while are bad at5 mathematics and learning quantities and numbers. Two problems have been asserted in the revised law of Education and Training for students with a learning disorder in the field of mathematics:

1. Calculation of math
2. Logic of math (Lerner 1995)

The followings are characteristics of children with dyscalculia:

1. Disorder in understanding spatial relations: more learning level of children is achieved through play with some objects such as dishes and containers and the boxes that can be put into each other, and the objects that can be placed in them. this type of play develops a sense of space, sequence, and order. Parents of children with disability in learning mathematics report that their children do not play with cubes, puzzles, patterns, and building toys and do not like such plays (Lerner 1995). Students with mathematical disabilities may have obtained early experiences in learning numbers and figures. Disorder

in understanding spatial relations lead to disorder in learning numerical system. Some solutions have been mentioned in the table to overcome this challenge.

2. Problems related to math and difficulty in quantitative thinking: for better learning of mathematic concepts, teachers can use real, tangible, and touchable objects, such as beads, peas, and beans. Counting the number of objects available in the environment, such as chairs, tables, etc., and use of clay dough and sand, weighing objects with a scale can make it easy for students to learn mathematical concepts (Tabrizi 2014). The class must be equipped with the required tools, so it must be considered in the design of the setting.

3. Difficulty in time, space, and calculation data: to understand mathematical concepts, the subjects must be considered objectively then in illustrative and symbolic methods to help students understand the topic better (Tabrizi 2016). For this purpose, the setting must be designed (problem-solving room) attractively and organized (Lerner 1995).

Table 4. Treating Common Characteristics among Children with the Learning Disorder

Final Goal	Specification	Interventional Factors	Environmental Solution
	Short attention range (Maria and Cornoldi 2013)	Using auxiliary educational-painting instruments (Lerner 1995)	Using a space for study with the following properties: enough light and suitable temperature, lack of visual and auditory drivers, not-busy, lack of entertaining images and various objects, a proper chair and table for writing, using a dark setting for practicing concentration with a candle, painting, etc. (Tabrizi 2016). A school equipped with audio-video devices.
Treating Calculation Disorders (Common Characteristics)	Distraction, low ability for concentration/ lack of enough attention and focus (Maria and Cornoldi 2013)	Privacy, walking on a platform, painting, calligraphy, and fishing (Tabrizi 2016).	Using a quiet class, being away from the noise, and being simple, not using decorative and extra objects, pictures, using puzzle and color games, using a wall, small room, curtain, special room, quiet corners, and removal of disturbing stimulus. The space includes an area for students' activities, such as paper size and bench. The environment of school must not draw the attention of students towards unrelated stimuli for learning that may cause the disorder. The isolated stimulus-free space for those activities that need concentration such as exams, and the benches must be organized in a distance close to the teacher.
	Delay in motor growth and low motor ability	Occupational therapy, physiotherapy, swimming, exercise, painting, playing with clay and toys, motor-based games, running or walking on the letters, and activating the whole body (Lerner 1995). Hopscotch, skipping, jumping, throwing (Sedighi et al. 2021), and catching the ball (Wallace and McLaughlin 1995).	Adding gym, pool and enough space for mentioned practices
	Difficulty in motor coordination	Practice walking on fours, crawling, holding a book on your head and walking in different directions while keeping balance (Tabrizi 2014), walking on the edge of the platform	Design of a tunnel, and concrete platform next to the gardens in the courtyard

Final Goal	Specification	Interventional Factors	Environmental Solution
	Difficulty in short memory	Creating motivation to draw attention and exchange the information from the sensory record to short-term memory and doing some practices, such as mental imaging and using reminders to exchange information from short-term to long-term memory (Saif 2007).	Normal classroom setting
	Conceptual disorder, poor cognitive and conceptual growth	Play with sand (Malekpour 2012)	Creating a greenhouse setting
	Perseveration	Multistage or multiple group plays, motor plays (Baradaran, Safavi Homami, and Faramarzi 2021)	Gym
	Perceptual disorder	Playing with shape and ground (background and foreground) (Lerner 1995).	Using various colors, playing with light and shadow, using sketches, and motifs in interior design, setting richness in terms of light, color, and sound
	Behavioral disorders: hyperactivity, nervous and aggressive, anxiety, moods with sadness and grief, poor self-concept, forgetting things, disorder in activities, unbalanced and reckless behavior, always doing an action, easily being despaired (Baradaran, Safavi Homami, and Faramarzi 2021).	Calming music, wordless preferably, stimulating senses and feeling in nature, sense of security, respect	Designing quiet corners in the space of the school, connection with the natural landscape and nature through the window, decorative elements such as aquarium or water, and lighting fireplaces (Kaplan and Kaplan 1989). Creating privacy and tenants for privacy in the plan.
	Depression and sense of loneliness in the child (Shirani, Hoseinpour, and Asli Azad 2020).	Play therapy, story therapy, creating new opportunities for behaving and making relationships with others, relationships with the nature	Making the space of classroom and therapy room attractive for the children, landscapes that can be seen through windows, lighting fireplaces, and decorative elements, such as the aquarium, and decorative water, and creating privacy or tenant for privacy in the design (Evans and Mitchell McCoy 1998), using natural light and illumination lamps with full range (Kripke, Risch, and Janowsky 1983), legibility and being close to geometric forms.
	Anxiety in the child (Rezaei, Sefidkar, and Qorbanpoor Lafmejani 2020)	Being supported	Using maximum natural light- full-range illumination lamps, not using florescent lamps (Kuller and Lindsten 1992), setting flexibility, indirect monitoring of the place, and attention in the space.
	Hyperactivity, unbalanced and amateur motions (Westendorp et al. 2011)	Motor plays, the possibility for movement, draining the extra energy of a child, football, climbing, walking, running, swimming, gymnastic, karate, etc.; commitment to activity (Baradaran, Safavi Homami, and Faramarzi 2021).	Assigning enough space for physical activities, using squared tatamis with some rings to determine the personal space when doing physical activities, using soft forms, avoiding sharp edges, designing monitorable spaces

Treating Calculation Disorders (Common Characteristics)

Final Goal	Specification	Interventional Factors	Environmental Solution
Treating Calculation Disorders (Common Characteristics)	Restlessness (Rezaei, Sefidkar, and Qorbanpoor Lafmejani 2020)	Instant encouragement and improvement during patience	The attractive setting of a classroom, using nude colors in interior design-creating private space (the space of class should be more or equal to the furnished space)
	Lack of motivation	Timely and reasonable rewards/using auxiliary learning devices such as computers (Greenberg et al. 2018; Sheikh Mohammadi et al. 2020), calculators, and voice recorders to increase students' motivation (Lerner 1995).	Normal classroom space, gym
	Impaired general body coordination	Plays that make children jump or run, activities like cycling and walking (Vameghi, Shams, and Shamsipour Dehkordi 2013).	The setting of the gym or school courtyard
	Aggression (Rezaei, Sefidkar, and Qorbanpoor Lafmejani 2020)	Calming music, wordless music is preferred, simulating feelings in the nature	Doing homework in open space-visual and auditory communication with nature, playing calming music, separating collective and personal independent spaces of the child, designing adjacencies that are suitable for the educational space, improving environmental comfort, using green space in the open environment of the complex, using natural elements such as water, plants and flowers, view towards natural landscapes, optimal use of natural light, controlling the noise outside and inside the school by planting trees or using other artificial insulations such as double-glazed windows and sound insulators, setting legibility, increasing sense of security by designing walls and fences around the place, observing the safety principles in the design by creating a sense of security and mental peace
	Lack of self-confidence (Grigorenko et al. 2020)	Instant encouragement and improvement, sense of productivity and competency, storytelling, encouraging to do activity in small groups or interested focuses, removing the experience of failure within the children's education process, design of setting to nurture the individual creativity and intelligence specification of the child, increasing sense of security and respect	Assigning a part of gym space to group-based plays- story scene, using nature elements, maximal use of natural light, physical safety, using calming forms and avoiding sharp edges, designing free and flexible plans, using natural materials, architectural usage of water, designing and creating complicated and challenging spaces, design of flexible spaces.
	Dependence of parents, and separation anxiety (Wallace and McLaughlin 1995)	Simple plays such as hide-and-seek, play with puppets	Educational space of the courtyard, design of the scene
	Lack of organizing ability (they do not know how to earn or study), incomplete homework	Consider specific places to put their objects especially those that they use daily, such as books, notebooks, and cloths used outside the house, preparing small booklets to organize educational materials in them/using a special color for each lesson (Lerner 1995). Using auxiliary educational-painting tools	Shelving the class wall, creating niches in walls, and school equipped with visual-audio devices

Children with learning disorders have various characteristics, so may not indicate all of these properties; however, their common specifications and relevant treatments are reported in the table.

5. MODELS FOR SERVICE PROVIDING

Determining the educational place for children is one of the substantial components in the process of evaluation and education of children with learning disorders. Since children with a learning disability have different needs based on their disabilities, the schools must provide a set of educational places to provide the best services considering the different needs of these students. Deciding on the amount and level of diagnostic services depends on the severity rate of problems. The services can be provided within seven models as follows:

a) Normal Classroom Model

These classrooms are designed for those students that receive a major part of an educational program in the public classroom, while special education is provided for them in the same classroom (Lerner 1995).

b) Consultation Model

The learning disabilities consultant provides services for those who suffer from learning disorders helping the teachers of normal classrooms, other staff, and parents in this process. The followings are the tasks that a consultant does: evaluation, program plan, preparing materials and coordinating them, indicating methods, and evaluating the program. consultant does not directly participate in the education process of a child with a learning disability. This model can meet the needs of children with mild learning disabilities.

c) Mobile Model

In this technique, the initial classification is done then

the mobile teachers go to different schools and centers to help children. They are responsible for diagnosis, education, and consultation. After spending one or more days in a school, they guide the educational staff of the school and provide them with the required materials and activities to pursue their tasks.

d) Reference Room Model

The reference room is a problem-solving room designed for those students that must spend at least 21% and a maximum of 61% of their time outside the public classroom, so they can receive special education and services in this class (Lerner 1995). The reference room model can meet the need of students with mild and moderate and even some severe learning disabilities.

e) Special Classroom Model

Few children with a learning disability need full support in special classrooms, so this strategy is usually used after working with the child in the reference room and obtaining the diagnostic and educational experience.

f) Special Daily School Model (Separate School)

Some educational areas of a special school are allocated to programs related to learning disabilities. Children attend school full-time or part-time throughout the day. In this case, the local facilities, including expert staff and educational materials are concentrated in the school.

g) Boarding School Model

Boarding schools for children with a learning disability are generally used for a few cases with severe disorders or in situations where local services are not available.

Table 5. Advantages and Disadvantages of Service Models

Advantages and Disadvantages of Service Models		
Model	Advantages	Disadvantages
Normal Classrooms	An environment with minimum limitations provides the field for the relationship between children with learning disability and their normal peers. Preventing labeling children without any reason.	Educational factors make learning disabilities more complicated. A high number of students are in a classroom. The teacher is not trained for learning disabilities. Education is not available in small groups or individuals.
Consultation	More access to teachers; Ability to prepare special educational techniques, programs, and materials; Possible education for more children; Influencing the environmental learning variables; Coordinating the comprehensive services for the child	The consultant may not be considered a member of the educational board. Lack of first-hand information achieved from teaching the child. The possible separation between evaluation and education.

Advantages and Disadvantages of Service Models

Model	Advantages	Disadvantages
Mobile	<ul style="list-style-type: none"> Classification and diagnosis of disabilities; Providing some consultative services, providing part-time services; Meeting the needs of children in different schools and scopes; A cost-effective method for treating mild cases. 	<ul style="list-style-type: none"> Spending more time for children who need continuous services; Lack of similarity to school staff; Difficulty in transporting the devices; Program non-continuity; Lack of common follow-up in other programs.
Reference Room	<ul style="list-style-type: none"> Alleviating the stigma attached to children; Emphasis on treatment through education; Extra education by attending the normal classrooms; Separating disabled students from normal peers for a short time in a day; Providing professional educational services individually by an expert teacher in a relevant field; Providing consultative services for normal classrooms of the child; Preventing from labeling children without any reason; Aiming that the child is considered in the main education and training process. 	<ul style="list-style-type: none"> Lack of ability to provide services for children with severe learning disability; Scheduling the problems; Misconception of the teachers' role; Interference of individual's roles; Lack of time for observation or consultation; Lack of time for evaluation and planning; Lack of confidence in efficiency; Excessive enrollment of children in a program
Special Classroom	<ul style="list-style-type: none"> An environment with the minimum limitation for severe cases; A setting for implementing the individual educational plan of the child; Providing the required conditions for meeting the needs of children with serious difficulties; Possible individual education or in small groups; Keeping the self-esteem of children; Acceptance of students; Full-time attention of the teacher; Providing full-time professional learning conditions. 	<ul style="list-style-type: none"> Dispersion; Excessive constraining on the mutual relationship between children with learning disability and their normal peers; The stigma attached to children; Risk of improper attendance of children in this program; That child may stay there based on an incorrect decision; Severe constraints on many mild and moderate disabilities; Providing improper behavioral models; Teachers' low expectations from students.
Special Day School	<ul style="list-style-type: none"> Full usage of limited sources such as professional staff and educational space; Providing services for many children with moderate and severe learning disorders; The concentration of diagnostic, educational, and consultative services in one place; A measure to provide a sample model and abundant use in the future; Providing special curriculum and setting; Providing a special setting and the privilege of staying home and being present in society for the child 	<ul style="list-style-type: none"> Lack of relationship with other normal peers during the day; Lack of a setting with minimum limitations for all cases; High expenses in some situations; Removal of pressure for local services development.
Boarding School	<ul style="list-style-type: none"> Professional internship; Paying attention to diet and required pharmaceutical treatment; Providing some facilities to being involved in all life aspects of the school within the planning framework; Providing the proper diagnostic and educational techniques 	<ul style="list-style-type: none"> Separating from the mainstream of the society; Extra costs and expenses; Not powerful and professional staff; Few signs of child exclusion from the program and a lack of a setting with minimum limitations; Quality control.

(Lerner 1995)

Experience indicates that few children need the services provided by all staff of diagnostic centers or clinics. According to research findings, educational space can effectively improve the performance, learning, and treatment of the child using architectural design techniques that are suitable for children with learning disorders. Architectural design principles for the improvement of performance among

children with learning disorders can be presented as mentioned herein. Table 6 reports the effect of each principle on improvement of the performance among children with dyslexia, dysgraphia, dyscalculia, and general characteristics of children. Table 7 indicates the different types of qualities influencing the improvement of performance among children with learning disorders.

Table 6. Classifying the Design Principles Affecting Children with Learning Disorders based on Different Disorders

	Design Strategy	Dyscalculia	Dyslexia	Dysgraphia	Common Specifications of three Disorders
1	Using the capacity of various lights, colors, designs, and motifs in the interior design, play with light and shadow		*		*
2	Maximum use of natural light				*
3	Use full-range illumination lamps, not using the fluorescent lamps				*
4	Using Persian carpet and tatami with different colors		*		
5	Designing the environment to encourage speaking and role-playing; design the story scene		*	*	
6	Sound echo		*	*	
7	Using mirrors in the interior design of special classroom		*	*	
8	Using Smart Banners in Classrooms		*		
9	Creating enough space for group plays; establishing the sport gym		*	*	*
10	Designing a tunnel in an area of the gym			*	*
11	Educational space must be preferably equipped with a swimming pool				*
12	Possibility to draw hopscotch cells on the ground of the yard or changing the color of cells on the tatami of the gym, using squared tatamis or rings to determine the personal space when doing motor activities		*		*
13	Design of a special classroom with sound insulation		*		
14	Design of an educational setting equipped with audio-video devices			*	*
15	Design of an educational setting equipped with a music room			*	
16	The classroom must have a locker to put tools, and installing signed lockers for students, shelve the classroom's walls, and create niches on the walls	*		*	*
17	Designing a chair or bench based on the ergonomic principle to set the hand movements			*	*

	Design Strategy	Dyscalculia	Dyslexia	Dysgraphia	Common Specifications of three Disorders
18	Installing a specific table to make handcrafts of the correct spelling of words			*	
19	Making the space of the classroom and treatment room (special classroom) attractive for children; designing a problem-solving room in an attractive and organized technique	*			*
20	Design of the studying space based on some specifications, such as simplicity, enough light, and suitable temperature, lack of audio and video stimulus, be-ing quiet and non-commutations	*			*
21	Lack of entertaining images and various objects, a proper chair and table for writing, using nude colors for interior design	*			*
22	The isolated stimulus-free space for those activities that need concentration such as exams, the benches must be organized at a distance close to the teach-er				*
23	Use a dark setting for practicing concentration with a candle, painting, etc.				*
24	designing an educational setting equipped with a pottery workshop			*	
25	creating a greenhouse space or garden in the courtyard, designing a concrete platform next to the gardens				*
26	design of the classroom environment concerning nature (visual and auditory communication) with the nature, doing homework in the open space, the natu-ral landscape seen through the window, architectural use of water, designing decorative elements such as an aquarium or water fountain, and lighting fire-places				*
27	creating privacy and tenants for privacy in the design, creating quiet corners in the educational environments, and separating the public and personal spaces of the child properly				*
28	legibility and similarity of space design with geometric forms				*
29	designing flexible spaces, using educational workshops with open plans peri-odically	*			*
30	playing calming music in the educational space				*
31	paying attention to adjacencies suitable for educational space, improving envi-ronmental comfort, creating a sense of security and mental peace observing the safety rules in design, and creating walls and fences around the complex				*
32	controlling the noise inside and outside the school by planting trees or using other artificial barriers				*
33	using soft forms and avoiding the sharp edges				*
34	design and create complicated and challenging spaces	*			*
35	design of monitorable spaces				*
36	using natural materials				*
37	design of the show scene		*		*

Table 7. Classifying the Qualities Affecting the Improvement of Performance among Children with a Learning Disorder

Design Qualities	Design Strategy	Form Features	Spatial Features	Arrangement Features	Decorative Features
1	Using the capacity of various lights, colors, designs, and motifs in the interior design, play with light and shadow	*	*	*	*
2	Using Persian carpet and tatami with different colors				*
3	Maximum use of natural light		*	*	
4	Using full-range illumination lamps, not using the fluorescent lamps				*
5	Using a dark setting for practicing concentration with a candle, painting, etc.		*		
6	Sound echo		*		
7	Design of a special classroom with sound insulation		*	*	
8	Design of an educational setting equipped with audio-video devices				*
9	Design of an educational setting equipped with a music room	*	*		
10	playing calming music in the educational space		*		*
11	controlling the noise inside and outside the school by planting trees or using other artificial barriers	*	*	*	
12	Creating enough space for group plays; establishing the sport gym		*	*	
13	Designing a tunnel in an area of the gym	*	*	*	
14	Educational space must be preferably equipped with a swimming pool		*	*	
15	Possibility to draw hopscotch cells on the ground of the yard or changing the color of cells on the tatami of the gym, using squared tatamis or rings to determine the personal space when doing motor activities	*	*	*	*
16	Designing the environment to encourage speaking and role-playing; design of the story scene	*	*		
17	design of the show scene	*	*		
18	Using mirrors in the interior design of special classroom				*
19	Using Smart Banners in Classrooms				*

Design Qualities	Design Strategy	Form Features	Spatial Features	Arrangement Features	Decorative Features
20	The classroom must have a locker to put tools, and installing signed lockers for students, shelve the classroom's walls, and create niches on the walls	*			*
21	Designing a chair or bench based on the ergonomic principle to serve the hand movements				*
22	Installing a specific table to make hand-crafts of the correct spelling of words				*
23	Arrangement and Furniture Qualities Making the space of the classroom and treatment room (special classroom) attractive for children; designing a problem-solving room in an attractive and organized technique		*	*	
24	Design of the studying space based on some specifications, such as simplicity, enough light, and suitable temperature, lack of audio and video stimulus, being quiet and non-commutations		*	*	
25	Lack of entertaining images and various objects, a proper chair and table for writing, using nude colors for interior design				*
26	The isolated stimulus-free space for those activities that need concentration such as exams, the benches must be organized at a distance close to the teacher		*	*	
27	designing an educational setting equipped with a pottery workshop		*	*	
28	Design based on the Perception and Senses Concerning the Nature creating a greenhouse space or garden in the courtyard, designing a concrete platform next to the gardens	*		*	*
29	design of the classroom environment concerning nature (visual and auditory communication) with the nature, doing homework in the open space, the natural landscape seen through the window, architectural use of water, designing decorative elements such as an aquarium or water fountain, and lighting fireplaces	*	*	*	*
30	using natural materials				*
31	Space Security and Mental Peace Quality paying attention to adjacencies suitable for educational space, improving environmental comfort, creating a sense of security and mental peace observing the safety rules in design, and creating walls and fences around the complex	*	*	*	
32	creating privacy and tenants for privacy in the design, creating quiet corners in the educational environments, and separating the public and personal spaces of the child properly	*	*	*	
33	designing flexible spaces, using educational workshops with open plans periodically	*	*	*	
34	Form Quality using soft forms and avoiding the sharp edges	*			*
35	design and create complicated and challenging spaces	*	*	*	
36	design of monitorable spaces		*	*	
37	legibility and similarity of space design with geometric forms	*	*	*	

6. CONCLUSIONS

Research findings indicate that variation in educational setting components can improve the performance of

children with learning disorders. Because children with learning disorders have different needs, schools must provide a set of educational places to meet the various needs of these students providing them with

better services. Seven models (normal classroom model, consultation model, mobile model, reference room, special classroom, day separate school, and boarding schools) have been suggested as the educational space for children with learning disorders. The results of this study indicate some principles in the design of educational settings that have been classified based on their impacts on the improvement of performance among children with different types of

learning disorders (dyscalculia, dyslexia, dysgraphia, and common features of three disorders). The results show that architectural qualities (form quality, light and color-related qualities, sound qualities, functional quality, arrangement, and furniture qualities, qualities of design based on the perceptions and senses concerning nature, and security and mental peace of space quality) would improve the performance of children with learning disorder.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

ENDNOTE

1. Research instrument: a questionnaire was designed as a measurement instrument based on the questions asked in the study. To determine the validity, three learning disorder experts confirmed the questionnaire. In this questionnaire, a five-point Likert scale is used to quantify data:

Very low (1), low (2), average (3), high (4), very high (5).

The Likert scale is an interval scale in which, several items are built and half of them are favorable and the other half are unfavorable. Some steps must be taken to prepare the Likert scale. First, the items related to the subject are gathered. Then the item is given to the respondents, who are learning disorder experts in this research to answer the items based on a five-point Likert scale from very high to very low.

In this research, characteristics of the children with learning disorders and factors affecting the improvement of their performance were examined and extracted through authentic references and semi-structured interviews with three learning disorder experts. These characteristics and factors affecting them were formulated in a closed-ended questionnaire distributed among 20 experts in learning disorders. A suitable criterion was considered for each item based on the theoretical studies and results of previous papers. For this purpose, the considered criteria for each item are explained to analysts by the researcher. To measure the reliability coefficient, Cronbach's alpha coefficient has been used. According to computations, the reliability of the study equaled 0.91 using Cronbach's alpha formula. In this formula, K represents the number of questions, σ_i^2 is the variance of each item, and σ^2 is the variance of the whole items.

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K \sigma_i^2}{\sigma^2} \right)$$

According to the research background on this subject, 36 unfavorable performances were extracted in the frame of 36 variables and components with different concepts. In the next phase, interventional factors affecting the removal of these unfavorable performances were identified based on the available studies. A closed-ended questionnaire of interventional factors was prepared to confirm the findings. The validity of this questionnaire was confirmed by three professionals in the field of learning disorders. This questionnaire was filled out by 20 experts (the questions are attached to the appendix).

Attitude assessment of architecture experts using an open-ended questionnaire:

Attitude assessment was done among architecture experts using the open-ended questionnaire after the previous steps. This questionnaire explained the obtained variables and mechanisms of variables' effects conformed in the previous step, and then the architecture experts were asked to propose the strategies used by architects and design techniques applied in the architecture system to achieve the mentioned goal.

This survey was done among five experts in educational architecture and researchers by asking 6 questions. The questions were about the strategies for educational space design that have a positive effect on human variables and can improve the performance of children with learning disorders.

Ultimately, after the interview and collecting the responses, the analysis and conclusions of proposed strategies were summarized and the answers were presented in the frame of certain items.

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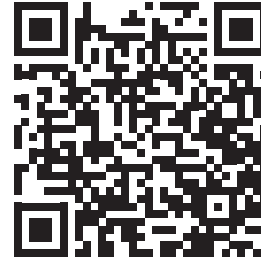
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