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The Role of Sensory Gardens in Autistic Children

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Abstract*— The purpose of this study is to examine the impact of therapeutic or sensory gardens in the behavioral and learning aspects of children with autistic disabilities. To understand the same, a total of 30 students between the age group of 4 to 10 were examined from an autism school in Tirunelveli, Tamilnadu. The study was conducted through observational analysis and structured interviews with doctors, caregivers, and teachers of the school. The result shows that sensory gardens have a considerable impact on autistic children as it helps them in improving their communication skills and positive behavioral changes. The study also shows that the sensory gardens enhance the learning focus in autistic children and the guidelines based on the same have been formulated.

***Index Terms*—Autism spectrum disorder, Learning focus, Primary schools, Sensory garden.**

I. INTRODUCTION

In 2016, the American Psychological Association stated that Autism Spectrum Disorders (ASD), also known as "autism," is a developmental disorder that affects a person's ability to communicate. Usually found before the age of 3. Children with autism are afflicted with deficits in neuropsychology or psychology influence their behavior, communication, and social interactions occurrences (Norfishah, 2015)[1]. It is difficult for autistic children to communicate, Interact with others, obstructing the process of interaction with strangers in social settings (Hasnah Toran, Salmiah Bujang & Fadliana Chiri, 2013; Norfishah, 2015). Autism speaks in 2013 enhanced that Autism is frequently related with communal problems. Interactions, linguistic and nonverbal communication, and repetitive behavior Language and communication are essential for establishing social interactions in human life henceforth an approach to be taken to assist autistic children in being able to converse either verbally or nonverbally (Flippin, Reszka). The surrounding environment influences the developmental process of children's learning, in which they use the direct experience to learn quickly (Ramadhani, 2016)[2]. The school-accessible sensory garden allows children to play and explore (Titman, 1994). Titman (1994) identified four components of children's learning in the school garden. The locations include a space for physical activity, a space to think intellectually, a space to express feelings, and a space to be independent. All of the above activities are to be done in the children's green space.

II. RESEARCH QUESTIONS

- What is the effect of learning in the sensory garden on autistic students between the age of 4 and 10 ?
- How should a garden space designed for autistic children in a leaning environment?

III. METHODOLOGY

Researchers used Desktop Case studies, observational study and structured interview as main protocols for the research. Observational studies carried out among 26 autistic students of age between 4 and 10 in a primary school and the structured interview is carried out among the doctors, care givers and teachers in order to understand the curriculum, behavior of autistic children in a learning environment.

IV. LITERATURE STUDY

A. Symptoms or Characteristic of Autistic disease

There are three major categories of Characterizing Autistic disease. They are

- Social interaction
- Speech and communication
- Restricted/repetitive behavior

The symptoms of the autistic disease are visible during social interactions. Inability to express emotions through facial expressions, inability to make direct eye contact, inability to express emotions, and inability to smile socially Inappropriate facial expressions and social responses, Difficult to understand, build and maintain relationships and share joy with others. Symptoms of autism in speech and communication are delayed speech and lack of communication gestures[3] such as nodding and shaking the head. Difficulties starting and maintaining verbal communication Restricted/repetitive behavior is one of the symptoms of the autistic disease that shows unusual preoccupations and limited interests, hand flapping and toe walking, intense interest in unusual activities for their age, and so on. Pain/temperature apathy, need for a predictable routine, stereotypical motor movements, and speech.

B. Problems integrating sensory information

In 1987 Scardina defines integration of senses as the ability to consruct, understand, and feel sensory data from the environment or one's body (cited in Wilson, 2006, p.10.).

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According to Grandin in the year 1995 and Williams in the year 1992, people with autism have problems refining, merging, and classifying sensory information (cited in Wilson, 2006, p.10.). Responses to sensory information or stimuli range from hypersensitivity to hyposensitivity (Henshall, 2008). According to Henshall in the year 2008, when the brain is hypersensitive, it cannot process large amounts of information coming in through wide open sensory channels. In contrast, hyposensitivity occurs when the sensory channels are not open enough to pass sensory inputs, resulting in depletion of sensory inputs to the brain. People with hypersensitivity are hyper active and sensitive to certain actions, and certain sensations can be overwhelming and painful to them, resulting in a strong reaction.

C. Hyposensitive and Hypersensitive symptoms of ASD

Gaines et al in the year 2016[4] said that The term "hypo sensitivity" means slow response, as if certain sensory information is overlooked or impaired. Children diagnosed with hyposensitivity, who tend to listen, were often mistaken for hearing-impaired. Gaines et at in 2016 said that the People with hyposensitivity are often referred to as "sensory exploration." This means creating a unique sensory experience for joy or blocking other unpleasant stimuli. The Autism Association stated in 2015 that this situation is a very complex condition that affects people with autism differently and benefits more from the sensory input of the constructed environment.

The term "Hypersensitive" refers to people who are excessively sensitive to sensory stimuli. Sensitive children can sometimes be easily overwhelmed by scary environments. When children with autism start their process of learning, the environment's quality is very critical as said by beaver in the year 2011[5] to avoid confusing and frustrating the mind of autistic children. Gaines, bourne, pearson and kleibrink in 2016 said that sudden loud noises would cause physically painful to them. Gaines et al. in the year 2016, said that some experts said they believed that people with Asperger's syndrome were more subject to over stimulation than others.

Senses	Hyposensitivity	Hypersensitivity
Auditory	• No answer when called by name. They like weird sounds. • Likesthunderous and uncontrolled sound	• Very sensitive to loud noise. You seem to hear the noise before others. Inability to handle background noise normally - avoidance
Tactile	• Unnecessarily touch people and things. There is an unusually high pain threshold (they do not appear to be injured after a severe fall). They don`t appear to sense the intense temperature	• Avoid wearing certain fabrics. feel restless during care. don't like getting wet or walking barefoot. Feeling uncomfortable when touched
isual	• Taking no notice of people or objects in the environment. Can only see the outline of a specific object. Loves bright colors and bright sunlight.	• Disturbed by bright light (eyes closed or squinted); easily distracted by movement; see a specific person or thing
Vestibular	• Move around unnecessarily. They like to go around in a circle. Enthusiastic about all movement	• seems out of balance; Frustrating to stand upside down or lift your feet off the ground
Olfactory	There are also reports of using low-nutrient Picador substances by "groping" by mouth; Look for strong smells. ignoring some taste	People selectively eats; Eat only foods with a specific texture, smell, or temperature
Proprioception	Don't know the position of the body in space or the feeling of hunger. Frequent leaning on people or objects	Strange poses; Inconvenient in most situations. Difficulty handling small objects

D. Sensory gardens

The sensory garden uses a variety of plants and materials to stimulate all senses such as seeing, feeling, tasting and listening. This garden allows people with autism to explore their emotions in a safe and stimulating environment. The Sensory garden is a self-contained garden area where visitors can experience different sensations. Sensory Gardens are designed to provide sensory stimulating opportunities, individually or in combination, in ways that users do not normally encounter. The Sensory Garden has a wide range of educational and recreational uses. They can be used to educate students with special needs, including people with autism. According to Hussein (2011), [6]the sensory garden

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is a park carefully designed so that all components such as landscape, color and texture provide maximum sensory stimulation. Therefore, the sensory garden approach can enhance a child's multisensory stimulus to stimulate the child's senses. Garden design elements and colorful vegetation create vibrant visual contrast and a more pleasing auditory, visual, tactile, odor, and taste experience (Wysocki, 2003; [7] Dabski and).

Dudkiewicz, 2010; Wysocki, 2010; Worden Moore, 2013). In addition, the environment influences the child's learning development process by utilizing direct experience to learn it quickly (Ramadhani, 2016). The school-accessible garden makes it easy for children to play and explore (Titman, 1994). according to

Titman (1994)[8] identified four elements of child learning in the school yard. The place is a place for physical activity. A place for intellectual thinking, a place for expressing emotions, and a place for independence.

E. Effect of children's senses on the Environment

The effect of children's senses on the environment are tabulated below

Senses	Characteristics of Senses
Visual	• Visual recognition ensures that you receive the most comprehensive information from your environment. • Provides information about the nature of the object. • It encourages children to come into contact with environmental elements and prepare their condition to face other sensations (2007 day). • This is considered a navigator factor in your environment. • Provides information on how environmental factors affect children.
Smell	• Fragrances are used to improve mood and change people's views and mental functions of the environment. But in fragrances reduce stress and improve the mood and strength of the child (Augustin, 2009).
Auditory	• Sound helps children learn more about the world around them. In fact, listening to the sound is the same as experiencing it around you. • Children like to hear unusual sounds (tunnels, caves, walls that reflect sound). Because these sounds stimulate your imagination. • Disruption of room acoustics reduces children's understanding (Spencer & Blades, 2006). • Provides information on how environmental factors affect children
Taste	• Children taste things with their tongue many times. This is a natural reaction to understanding the environment (2007).
Touch	• It has an important relationship with the child's emotions and emotions, and children tend to touch things. • Children use this sensation to communicate with space, which helps them better understand the environment.

V. DESKTOP CASE STUDY

Three desk top case studies[9] are identified and studied in detail about the planning of a sensory garden based on the behaviours of the autistic children

Case study 1	Case study 2	Case study 3
King Mariout zone in the west of Alexandria, egypt	**The sensory garden of the royal school of deaf and communication disorders, Manchester, United kingdom**	**Lyndale school, Wirral, England**
Use of Large open spaces ■	Use of Large open spaces ■	Use of Large open spaces ■
Use of interactive sound effect △	Use of musical pipes △	Use of musical pipes △
Use of radial and symmetry ▬	Use of radial and symmetry ▬	
Use of radial and symmetry	Use of radial and symmetry	
Use of vivid colours ■	Use of vivid colours ■	Use of vivid colours ■
Use of fluid lines in walkways □	Use of fluid lines in walkways □	Use of fluid lines in walkways □
Use of rounded edges ▬	Use of rounded edges ▬	Use of rounded edges ▬
Provide some sunlight ■	Sunny areas are provided ■	
Insert therapy cat for petting ▭		
Repetition of trees □	Repetition of trees □	Repetition of trees □
Use of fish tank ⬬		
Use of varied topography ▬		
Use of artistic and beautiful spaces □		
Use of brightly coloured steps and ramps ▬		Use of rainbow coloured walkways – rainbow walk ▬
Use of texture in plant material ⬭		

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Use of trickling water fountain △		Use of interactive fountain with talking tubes △
Use of bird feeders to bring in birds ▲		
Use of colourful bird feeder houses □		
Use of fragrant plants ▮	Use of fragrant plants ▮	Use of fragrant plants ▮
Use of soft play feature ▬		
Use of multiple ground textures	Use of multiple ground textures	Use of multiple ground textures
Use of wide walkways ▬		
Use of climbing equipment ▬		
Use of rocking equipment ▬		
Use of swinging equipment ▬		
Use of grassy hill to roll down ▬		
Use of balancing equipment ▬		
Use of natural object as focal point □	Use of water feature as focal point □	
Use of tumbling waterfall △		
Use of water feature with sound △	Use of fountain like water feature △	Use of fountain like water feature △
Use of swimming pools □	Use of water ponds □	Use of water ponds □
Use of sloped walkway ▬	Picture exchange communication system is done in pathways ▬	Use of sloppy lawn ▬
Use of highly fragrant plants ▮	Use of soft textured plants with pastel colours ⬬	
Use of no fragrant plants ▯	Use of varied texture plants ⬬	
Use of less vegetation □	Use of less vegetation ■	Use of dense vegetation □
Use of hobbit tunnel ■	Use of willow tunnel □	Use of covered tunnel □

Legends:

■ Stimulating effect for hypo reaction to visual

□ Calming effect for hyper reaction to visual

▲ Stimulating effect for hypo reaction to audio

△ Calming effect for hyper reaction to audio

⬬ Stimulating effect for hypo reaction to tactile

⬭ Calming effect for hyper reaction to tactile

▮ Stimulating effect for hypo reaction to olfactory

▯ Calming effect for hyper reaction to olfactory

▬ Stimulating effect for hypo reaction to vestibular and proprioception

▭ Calming effect for hyper reaction to vestibular and proprioception

VI. SURVEY

Questionnaire survey have been done among the teachers, and doctors who take cares of autistic children. The Survey questionnaires and results are as follows.

A. Data collection

How successful do you think your existing outdoor space is in the following ways? (Rate 1 to 5 scale in which 1 is very successful and 5 is not successful). All values are in %

Activity	1	2	3	4	5
Staff surveillance from inside		71	21	8	
Security for children	14	71	15		
Observing nature/birds	14	57	29		
Allowing children to wander safely	22	64	14		
Organized group activity	7.14	42.86	14.28	28.58	7.14
Helping students feel independent	7.14	50.00	14.28	28.58	

How often is your outdoor space used for the following purposes? (Rate 1 to 5 scale in which 1 is Often and 5 is Never)

Activity	1	2	3	4	5
Planned group activities	14.28	50.00	28.58	7.14	
Celebration	42.86	57.14			

How likely are these possible responses if students and staff are not using outdoor space? (Rate 1 to 5 scale in which 1 is Very likely and 5 is Not likely)

Activity	1	2	3	4	5
The area is exposed to sun, wind, etc	21.43	78.57			
There is nothing to do outside	7.14	71.43	21.43		

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The area is not enclosed		92.86	7.14		
Students are not allowed outside alone		35.72	7.14	50.00	7.14
Students feel insecure when outdoors		42.86	14.28	35.72	7.14
The area is exposed to sun, wind, etc	21.43	78.57			

How often do you see students doing the following activities when they are outdoors? (Rate 1 to 5 scale in which 1 is Very often and 5 is Never)

Activity	1	2	3	4	5
Sitting in the shade	35.72	57.14	7.14		
Sitting in the sun	14.28	42.86	28.58	14.28	
Observing nature/birds/insects	7.14	64.28	28.58		
Wandering	50.00	50.00			
Doing garden related activities	14.28	57.15	21.43	7.14	
Walking with others		7.14	28.57	42.86	21.43
Walking alone	29	71			
Visiting with others			14	29	57
Organized activity		21	21	29	29

Do you think most students can do the following ? (Rate 1 to 5 scale in which 1 is Very capable and 5 is Not capable)

Activity	1	2	3	4	5
Repotting plants		71	21	78	
Planting seedlings		50	36	14	
Walking outdoors	50	50			
Bird/animal/insect watching	7	64	29		
gardening activities like sweeping, etc	7	79	7	7	
Watering flowers		86	14		
Filling bird feeders	7	57	22	14	

How often do you use these calming techniques when dealing with restless, aggressive, or student behavioral behaviors? (Rate 1 to 5 scale in which 1 is Very Often and 5 is Never)

Activity	1	2	3	4	5
Soothing discussion	22	64	7	7	
Walking with student indoors	8	28	42	22	
Walking with student outdoors	57	43			
Suggesting a change of activity	7	79	14		
Giving them time alone	22	64	14		
Physical Exercise		14	14	58	14

How does the existing outdoor space facilitate the reaction of the students? (Rate 1 to 5 scale in which 1 is Very Often and 5 is Never)

Activity	1	2	3	4	5
Increase in general awareness		36	36	28	
Maintaining daily life skills		57	43		
Support Abilities		36	43	21	
Challenge or provide practice for new abilities		43	43	14	
Freedom to go outdoors		79	21		
Sense of ownership		71	21	8	
Security for family		71	21	8	
Encouragement of typical social roles		86	7	7	
Physical Exercise		50	14	36	

B. Data analysis

The survey is conducted among teachers, doctors, caregivers (14 respondents among which 6 doctors, 4 doctors and 4 caregivers) who take care of autistic children regarding the use of their existing garden space.

1. Most of them answered that the garden is very successful in staff surveillance from inside, security, organizing group activity etc. The outdoor garden

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space is often used for planned group activities and celebration.

2. At many times the outdoor space is unused since the area is exposed to sun, wind etc, The area is not enclosed, there is nothing to do outside and the students feel insecure when outdoors.
3. Mostly students sit in shade observing nature/birds/animals/insects. They wander here and there in the garden space doing garden related activities etc.
4. The students are capable of repotting plants, planting seedlings, walking outdoors, watching animals/birds/insects. They undergo gardening activites too, watering flowers and filling bird feeders.
5. It encourages the children in increasing the general awareness, maintaining daily skills, freedom to go outdoors, sense of ownership, security for family, encouragement of typical social roles and in encourages physical exercise to make them physically fit too
6. During restless, aggressive behaviors, soothing discussions are done with students to calm them. Walking with students in the outdoors, suggesting the change of activity and give them time alone also the few of calming techniques carried out

VII. RESULTS AND CONCLUSIONS

A. Formulation of Guidelines

The Guidelines are formulated based Design principle, Design element, Physical landscape feature, Landscape resources and materials, Special considerations[10]

B. Guidelines based on design principle

Guidelines based on design principles such as Balance, Unity and harmony, Rhythm, Scale and proportion, emphasis are formulated.

Design Principle	Calming effect for hyper sensitive children with ASD	Stimulating effect for hypo sensitive children with ASD
Balance	• Planting should be done in asymmetrical, Clump and gap plans	• Use of radial and symmetrical balance
Unity and harmony	• It should be easy to predict how the plan will continue. It is important to repeat elements regularly	• Variety of heights, areas volumes etc must be used
Rhythm	• Use of fluid lines on sidewalks • Use of patterns in planting beds	• Changes in the topography must be provided • Plant beds should be used in a natural and unforeseeable way
Scale and proportion	• The size of the plants and the ratio of open and green spaces should be the same • It is necessary to make a small space for the child.	• Use of different sizes and proportions of plants and open spaces • Need to change the size and proportion of the plant • Need to create a large space for your child.
Emphasis	• Use natural objects as focus • Must use predominant tree and shrub grouping	• Provides the ability to encourage promotion of focus like an bounce house • Focus must have different textures and shapes

C. Guidelines based on design elements

Guidelines based on design elements such as Colour, Forms, Line and Texture are formulated.

Design Elements	Calming effect for hyper sensitive children with ASD	Stimulating effect for hypo sensitive children with ASD
Colour	• Pastel color palettes should be used like green, blue, purple and so on. • Must use a single color scheme	• Should use a palette of bright colors such as red, yellow and orange • Must use complementary color scheme
Forms	• Use of rounded organic shape. • need to create a small space	• Need to use geometric shapes. • Large sized open areas need to be created.
Line	• Should use horizontal lines and curves with a symmetrical design. Calm signal	• Need to use vertical and diagonal lines. Shows movement
Texture	• Should use finely textured or single colour schemed plants. • Need to use a smooth finished hardscape	• Need to use plants of a different color and the coarse textured plants • Need to use a coarse finished hardscape

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D. Guidelines based on physical landscape features

Guidelines based on physical landscape feature such as Circulation, Land/Form, Micro climate, Plant material, Spatial organization, Views are formulated.

Physical landscape features	Calming effect for hyper sensitive children with ASD	Stimulating effect for hypo sensitive children with ASD
Circulation	• At the end of the path, need to create an assembly point • Space to sit and relax should be created in the circulation	• Need to make terrain changes to the path • Pathway should be done from a shaded place to a sunny place
Landform/ slope	• Have to use small slopes that will bring challenges to help them	• Grassy hills must be rolled down.
Micro climate	• The plant should be used to provide a dense shaded area. • High walls should be provided to prevent exposure to the wind for tactile sensation	• Providing a sunny place for tactile stimulation • Need to create an empty space to allow the movement of the wind
Plant material	• Some seating areas require the use of fragrant plants in the downwind area. • Be sure to use plants with a soft texture. • should use a flower bed in pastel colors.	• It is necessary to use plants with a strong scent. • Tactile stimuli require the use of different textures of plants • need to use brightly colored flower beds
Spatial organization	• need to provide space to restore your senses. such as shrub caves/tunnels for hiding	• Spaces that invites high activity such as tumbling hill, waterfall, peeping walls must be provided
Views	• Must use a dense shaded tree canopy • Pastel colour flowerbeds	• Need to use a bright and sunny lawn • Vivid colour flowerbed

E. Guidelines based on landscape and resource materials

Guidelines based on landscape and resource materials such as Ground covers, site furniture, Water features, Therapeutic animals and walls are formulated.

Landscape resources and materials	Calming effect for hyper sensitive children with ASD	Stimulating effect for hypo sensitive children with ASD
Ground covers	• It is necessary to provide a glare-free surface. • should use color and texture symmetry. • Must use finely textured ground cover material	• should use a coarsely textured ground cover material. • need to create a small lawn.
Site furniture	• Must provide a bean bag or ball pit tent or "cave" • for a relaxing time-out • need to use a hidden lighting system	• Use of rocking chairs or hammocks. • Must use a well-defined lighting system
Water features	• need to create a stream with the function of water • Must use swimming pool • need to use a fountain	• Must use tumbling waterfall fountain • It is necessary to create a body of water to help distinguish sounds.
Therapeutic Animals	• Plant material that attracts butterflies, birds and pets. • White doves and trained dogs	• provide an aquarium that stimulates daily activities. • Dogs to play fetch • Cats to pet and brush
Walls	• Observation through a hole in a wall that stimulates eye muscle activity	• Wall Murals should be painted in bright, rich colors.

F. Special consideration

Guidelines based on special considerations such as Site locations, security, Specialized spaces, special lightings, challenge and recreational needs, providing a quiet place,

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Child nature interaction, opportunities for increasing coordination, motor skills, exercise and balance, Ease of maintenance, spatial flexibility in future, Guidance based on visual cues.

Site location	Choose a location with as little distraction as possible. High-pitched or buzzing sounds and the noise of the air conditioner compressor can be deafening. Children should hear soothing sounds such as spray, birdsong and wind.
Safe and secure	Children with Autism Spectrum Disorder (ASD) may be confused, intrigued, or wander around nearby entrances. Designing the exterior environment requires that managers be able to protect the garden of senses from unwanted interference from passers
Variety of specialized spaces and choice and control.	Choice and control will help us decide when to leave this room. People who can sit alone or in groups can help them feel in control. Then decide whether you want to sit near, far away, in the shade, or in the sun.
Consideration of special lighting conditions	People with ASD are often sensitive to light due to the nature of their sensory system. Therefore, care must be taken to ensure that sunlight is comfortable to see, and techniques such as dappled shading and filtered sun can be used to reduce exposure to the sun with rays of light.
Take into account both challenge and recreation needs	It offer different social/physical environments for everyone to discover and explore their difficulties. It can be difficult for a child with autism to break away from it. The other has to overcome his shyness to play with other children.
Providing a quiet place	Try calming activities such as a bamboo tunnel, a bamboo fence panel with viewing holes, or hiding under a low-growing tree to relax.
Child-nature Interaction	Acoustic explanations of nature, seasons and earth processes are very informative for children with ASD. Give child the opportunity to live in nature to provide a habitat for wildlife.They can interact with natural resources such as wind, sun, rain, and shade as a result of this. Allow for opportunities for planting and harvesting. Changing their life cycle or starting a new life in a different way is one of the most important activities for a child in a stressful situation.
Provide opportunities for increasing coordination, motor skills, exercise and balance	Offers a dedicated area with a variety of exercise and rides, as well as a space for quiet.
Ease of Maintenance	Design a therapeutic garden, easy-to-manage environment without relying on educators, therapists and professional educators. Choose a plant that requires less attention. The sprinkler system must be installed at the construction stage. Choose materials, structures, pavement patterns and furniture that are easy to clean and durable.
Spatial flexibility in future	Therapeutic gardens must be adaptable because the needs of the therapist change as new treatments and ideas are discovered, and the needs of children change as they learn and grow. A space should incorporate loose elements so that it can adapt without requiring time-consuming or costly repairs.
Guidance based on visual cues	Children use the photo exchange system to communicate with teachers and families. Therefore, the design of the open space should include a well-painted sign to convey ideas, intentionally use a particular game, or encourage sign language

VIII. CONCLUSION

A good way to support the recommendations demonstrated in this study is to design sensory gardens specifically for children with ASD. The project should also be subjected to a post-employment study so as to determine whether it is meeting the needs of students, parents, teachers, staff, and therapists. Further recommendations could be derived from the post-occupation assessment in terms of the design Children with autism could benefit from sensory gardens in the future. The concept of a sensory garden should be appropriate regardless of location, environment, or weather. In addition to the various landscape design elements, layering makes the design more manipulative. The result shows that sensory gardens have a considerable impact on autistic children as it helps them in improving their communication skills and positive behavioral changes. The study also shows that the sensory gardens enhance the learning focus in autistic children and the guidelines based on the same have been formulated.

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