# INCORPORATING THE BEHAVIORAL DIMENSION IN DESIGNING INCLUSIVE LEARNING ENVIRONMENT FOR AUTISM

**Rachna Khare and Abir Mullick**


## Abstract

In last two decades environment and behavior studies has profoundly influenced the practice of architecture and there is growing trend towards people-centered and evidence-based design. The field has tremendous application in designing for special needs; most of the researches on designing for special groups, accessibility codes and design guidelines are based on the functional needs of the users, necessity to explore potential of behavioral aspects to design for people with cognitive limitations is felt though. In the present research, the systematic study of behavioral features in autism has provided a wealth of understanding that is applied to the process of design.

There are several stages to this research project, in initial stage, learning behaviors of children, their strength and weakness in educational spaces helped in defining 'enabling environment' for autism, which is tested in the subsequent stages to provide evidence based body of knowledge that is expected to help architects and designers to design autism friendly inclusive educational spaces. The purpose of this paper is to present the enabling aspects of educational environment for children with autism and measure their affects on functional performance.



## Keywords

Autism and design, inclusive learning environments.


## Introduction

Educational spaces are best to foster inclusive design; the students learn benefits of inclusive environments in their formative years and this finally results in an inclusive society. Inclusive education needs a comprehensive strategy in which the role of physical environment should not be underestimated. Today with accessibility codes and design guidelines, inclusion of children with physical disabilities is successful to some extent whereas the inclusion of children with developmental disabilities lags much behind; autism is one of those complex developmental conditions. As we move ahead with inclusive education, we must ensure that educational environments support universal solutions applicable to broadest range of human abilities no matter how severe they are.

Autism is considered as one of the most challenging developmental disorders and regardless of its overwhelming occurrence (I), it is by and large unnoticed by the architects and designers as a condition that influences building design. As a result, it is excluded from all building codes and design guidelines. Autism

affects communication and social abilities of an individual. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements and unusual responses to sensory experiences (II). Children with autism are found in all countries in the world of different cultural expectations, different attitudes to education and disability and very different levels of resources (Jordan, 1997). Until recently it was considered as hopeless and incurable condition, but now with advancement in special education, it is clear that all people with autism can benefit from a timely diagnosis and access to appropriate services and support. Today with dawn of inclusive education in the world, it has become vital to explore the scope of environmental design for autism. The present research study emphasizes the need for a fresh approach in designing educational spaces for a supportive environment that teaches all children along with children with autism that they are valued members of the society.

## Objectives and Research Questions

The study is carried out based on the belief that 'Performance of pupils with autism is enhanced in appropriate physical environment'. The objective is to determine the enabling aspects of educational environments assisting children with autism that will lead to the development of successful and inclusive learning environment for autistic children. The study examines the following research questions:

a) What kind of limitations does the pupils with autism face in the physical environment due to their deficits and associated conditions?
b) What are the environmental design implications of teaching strategies used for children with autism in educational spaces?
c) What are the enabling aspects of environment that might improve functional performance of children with autism in educational spaces?
d) How this enabling environment for children with autism can be validated for evidence based future reference?
e) Does the environmental design aspects that are important for children with autism are also significant for able bodied children?

## Theoretical and Methodological Foundations

There are four stages to this research and design project (i) Recognize environmental design considerations to address educational and behavioural aspects (ii) Define design parameters that have a strong connection to autism (iii) Develop measurement scale to evaluate design parameters (iv) Establish evidence based, universally acceptable 'enabling environment for children with autism. Two sources of significant theoretical ideas on which the present research is based are the fields of disability studies and environmental-behavior studies. Largely research questions propel the study and a multistage exploration research based on these two theories is carried out.

### Disability Studies

Disability has been defined as any restriction or lack of ability to perform an activity. According to ICIDH model (WHO1980) (III), a handicap is not a synonym for disability. A disability refers to a physical, sensory or mental limitation that interferes with a person's ability to move, see,

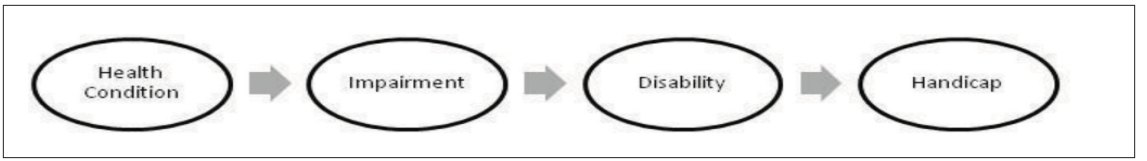


Figure-1: International Classification of Impairment Disease and Handicap (ICIDH) Model, WHO 1980 ICIDH model is criticized for not including physical and social environmental factors (Steinfeld & Danford, 1999). To include the personal and environmental factors, the research is built on the educational settings observed in different countries (UK, USA, India, and Germany). It is also ensured that the settings observed represent different cultural, socioeconomic, functioning level and age groups; however the data is not collected for individual students (Source: Authors).

hear or learn whereas the handicap refers to a condition or barrier imposed by the environment, society or oneself. Impairment, Disability and Handicap act as a linear cause and effect process (figure-1); that is the impairment causes disability and disability in turn lead to limitation in societal participation or 'handicap'. Majority of researches, building regulations, guidelines and design standards based on ICIDH Model have been focusing on reducing handicap by ensuring societal participation through environmental design (Steinfeld & Danford, 1999). The present research also follows the same path of improving functional performance of pupils with autism in educational spaces, consequently increasing their level of independence and societal participation thus reducing their 'handicap'. Based on the impairments in Autism, it attempts to develop an 'enabling environment' that is expected reduce their 'handicap' in educational spaces.

## Environmental and Behavior Studies

Research on design of environments for people with disabilities is usually based on the idea of that some state of 'fit' is definable and attainable. In most of the researches fit has been conceptualized as an environment that matches the abilities of the user with an appropriate level of support. The definition of an 'accessible environment' is typically based on the idea of fit between an individual's abilities and environmental features (Steinfeld & Danford, 1999, Steinfeld et al., 1979b).

In architectural design too, the key concept for the analysis of human behavior is the 'behavior setting' that includes only those aspects of physical environment that are critical to behavior. If the setting components are congruent with the behavior and its rules or purposes, there is a 'fit' between environment and behavior. This behavior setting concept and the twin concept of fit-misfit are the basic building blocks in architecture. A 'pattern' is a collection of fits in a single setting that supports a specific activity or behavior in variety of situations (Alexander, 1977).

To identify in the present study 'enabling aspects of environment for children with autism' first the 'behavior settings' for autism are identified. Then developed a 'collection of fits', where behavior arising out of their complex condition and deficits are in state of equilibrium with the environment. The 'pattern' observed in these environmental fits that supports a specific behavior, is the basis for defining 'enabling environment for autism'. When the person- environment -behavior relationship

is analyzed for educational spaces, it becomes extremely important to understand the role of teaching strategies in shaping the environment. It is another important variable to study when school design guidelines are based on educational performance of children. In the present research it becomes all the more necessary, as the teaching strategies for children with autism are different from regular school children.

## Environmental Design Considerations to Address Educational and Behavioral Aspects

Autism is a developmental disorder that leads to a different and characteristic pattern of perceiving, thinking and learning. To understand the needs of children with autism in the physical environment, it is necessary to know more about their deficits and behavioral characteristics. The present study tries to establish relation between learning behaviors and teaching strategies, and its implication on designing educational spaces, which is summed up in the table-A. Several authors have described autism and have grouped the features and behavior in their own way, present research takes widely accepted 'Diagnostic and statistical manual of mental disorders'-DSM-IV(IV) as defining tool for autism that is based on 'triad' of deficits (Jordan, 1997), social interaction, communication and repetitive behaviors. The study also includes 'sensory dysfunction', which is often associated with autism and is closely related with the perception of the environment. The 'environmental design considerations' that defines enabling environment for children with autism are identified based on (i) A Literature survey: to understand learning behavior of children in educational spaces (Siegel, 1998, Jordan, 1997, Maurice, Green & Luce, 1996, Schopler, 1995) (ii) A Field survey: to observe environmental interventions adopted in existing educational settings in various countries. These 'environmental considerations' are then summarized as 'design parameters' to recapitulate and evaluate enabling aspects of educational environment.

## Environmental Design Parameters with a Strong Connection to Autism

Literature on autism and environmental adaptations by teachers in the existing environment clearly define autism as a condition that affects environmental design. While summarizing the environmental design parameters (table A), eighteen design parameters emerged as the most dominating ones. These eighteen 'design parameters' that defines the enabling environment for autism and acts as a measurable quantity in the study are as follows:

- Provide Physical Structure
- Maximize Visual Structure
- Provide Visual Instructions
- Offer Opportunities for Community Participation
- Present Opportunities for Parent Participation
- Present Opportunities for Inclusion
- Maximize Future Independence
- Offer Generous Space Standards
- Provide Withdrawal Spaces
- Maximize Safety
- Maximize Comprehension
- Maximize Accessibility
- Provide Assistance
- Maximize Durability and Maintenance
- Minimize Sensory Distractions
- Provide Sensory Integration
- Provide Flexibility
- Provide Monitoring for Assessment and Planning

Physical structure sets clear physical and visual boundaries to segment the environment so that each activity is clearly associated with a physical space (TEACCH, 2004, Stokes, 2001), for example by strategically placing furniture to define individual and group activity, play, reading, snack and other areas in a classroom (figure 1.1). The segmented areas are further organized for the activities to be performed in that area, for example the independent work area may further be organized so that a child clearly knows how to carry out an activity.

Visual structure incorporates concrete visual cues in the environment, to utilize visual strengths of individuals with autism, to make them more independent (Hodgdon, 2005, Stokes, 2001). Visual structure may be used for different purposes in all environments in which children learn and play, for example in storage areas (figure 2.1), work areas or in common areas.

Visual Instruction is a way of giving necessary instructions or sequence of steps to follow an activity, using visual mode (Harker & King 2004, Stokes, 2001). Depending upon an individual's ability, it may be given in the form of written instructions, photographs, pictures, line drawings or visual schedules in the spaces where activities are to be performed. The instructions may be presented both in structured and naturalized teaching environments (figure 3.1), and other areas in the school building.

Opportunities for Community Participation refer to involvement in the community activities in every day occupations. For many pupils with autism the educational curriculum includes every day activities such as shopping, crossing the street, going to church or using public transport, thus, a location close to community activities (figure 4.1) is an advantage for educational spaces (Siegel, 1998, Jordan, 1997). The schools may also develop an environment to support teaching of such skills. Such activities may spontaneously lead to the integration in the community, as well as create training & job opportunities for the children with autism.

Regular Parent Participation in educating children with autism is very important for long term success. Participation is essential for goal selection in individualized educational plan to address their individual educational needs, parent teacher meetings and many other times (BB-94, 2001, Jordan, 1997). Possibility to observe children without distracting them is very helpful to deal with the issues together with teachers and therapists (figure 5.1).

Segregation of children with special needs is morally unjustifiable; it promotes isolation, alienation and social exclusion. Children with autism should be given opportunities in the educational environment to interact with able bodied peers (Young, 2004, BB-94, 2001). In Inclusion, they are placed in inclusive settings with 1:1 aide, modified curriculum and environmental support (figure 6.1) to accommodate their specific needs.

An environment that supports self help, domestic, vocational and Independent Living training help children with autism to live with dignity in future (Mostafa, 2008, Harker & King, 2002). Since a lot of children with autism do not learn these skills like regular developing peers, they have these goals in their educational curriculum. Environment supporting independent skill development includes provision of spaces supporting such training in the classrooms (figure 7.1), school lawns, cafeteria etc.

People vary in their attitude to the threat that loss of personal space or proxemics induces. People with autism can be sensitive about this and get threatened by crowding and react accordingly (Humphrey, 2005, Harker & King, 2002). A Generous Space Standard (figure 8.1) may help them deal with social stimulus comfortably.

Some people with autism are social isolates; many have difficulty in handling socially demanding situations and prefer to operate on fringes of social groupings. Providing Withdrawal Spaces is helpful for children, to avoid unnecessary stress and anxiety in socially demanding spaces (Harker & King, 2002, BB-94, 2001). Withdrawal area is used as a place for students to get away from distractions and stimulations (figure 9.1) and regain some self-control.

Children with autism are vulnerable in the environment due to their impaired communication, imagination and sensory dysfunction. Constant supervision is intrusive and difficult thus environment itself should be carefully assessed and managed for risks (Humphrey, 2005, Harker & King, 2004). Maximizing Safety refers to minimizing threats to the pupil within the school buildings due to their own condition, unawareness or any disaster. For safety in educational environment there may be concerns for escapes, sharp edges (figure 10.1), non toxic materials etc.

Complexity is not harmonious; it causes stress to everyone. For low functioning children with autism confusion easily takes-over, with complexity in layout, spaces, shape and form. Schools planned with simplicity and clarity maximizes Comprehension, thus less effort is required to understand, use and enjoy the building (Humphrey, 2005, TEACCH, 2004). A clear layout, organization of spaces, clear zoning, simple forms, and no visual clutter (figure 11.1) may assist children with autism to perceive the built environment easily.

Children with autism have selective hearing and limited communication skills. With box vision and poor attention span, they miss important details in the environment. They have poor coordination and balance and need assistance in spaces (Harker & King, 2002). All these conditions are similar to those with other disabilities, thus an Accessible Environment that supports children with physical and sensory disabilities (figure 12.1) is also helpful for children with autism.

Majority of the children with autism need aide in regular classroom, for 1:1 teaching, parallel teaching or group teaching, and a good numbers of teaching assistants are present in the teaching spaces with the lead teacher. Thus extra Space for Assistance is extremely helpful in the different areas like classroom, toilet (figure 13.1), dining areas etc. for teaching children with autism (Harker & King, 2002).

Overall we see a pattern in the behaviors of children with autism, but individual behavior may vary a lot. They may be accidently or deliberately heavy on the built environment, therefore, it becomes important that the building design reflects Durability and Easy Maintenance without mirroring the institutionalized feel (Humphrey, 2005, Harker & King, 2002). This is possible when architects design easy to clean surfaces, robust finishes (figure 14.1), strong furniture and equipments and fittings, those are serviceable and cheap to replace.

Some researchers believe that autistic behavior is credited to a form of sensory malfunction, when assimilating stimulatory information from the surrounding physical environment. Architect

through his design has control over this input and he can design calm and Least Distractible Environment (figure 15.1) conducive to learning (Mostafa, 2008).

Sensory dysfunction makes children with autism either oversensitive or under sensitive to the sensory inputs (as discussed in earlier); this effects their perception and understanding to the surrounding environment (Mostafa, 2008, Harker & King, 2002). Sensory Integration rooms or sensory areas provide multisensory opportunities in the environment (figure 16.1) that help children to integrate their senses for better understanding. Sensory integration calms children with under reactive senses and develops tolerance in over reactive children.

Figure 1.1: A classroom with segmented individual & group activity area (Source: Authors).

Figure 2.1: Color and number coded storage area in a classroom (Source: Authors).

Figure 3.1: Picture instructions for toilet activities (Source: Authors).

Figure 4.1: A location close to community pool is an advantage (Source: Authors).

Figure 5.1: A resource/parents room overlooking a classroom (Source: Authors).

Figure 6.1: An inclusive cafeteria with picture symbols (Source: Authors).

Figure 7.1: A corner in the classroom to teach self-hygiene(Source: Authors).

The combination of triad and sensory dysfunction result in broad spectrum of functional skills and interests in autism (TEACCH, 2004). Moreover, there are diverse teaching methods used for children with new researches adding every year. Teachers use these methods depending upon individual child's strength, weaknesses and interests (figure 17.1). Flexibility in designing educational environment helps to accommodate individual needs of children.

Figure 8.1: A large structured classroom with high ceiling and natural light (Source: Authors).

Figure 10.1: Safe play equipments with no sharp edges and corners (Source: Authors).

Figure 12.1: A ramp to access outdoor play area (Source: Authors).

Figure 9.1: A quiet space separated using partition in a class room (Source: Authors).

Figure 11.1: Clear and defined pedestrian movement to the school building (Source: Authors).

Figure 13.1: Space provided in self-help area to teach bathing skills (Source: Authors).

Figure 14.1: Robust outdoor play equipment (Source: Authors).

Figure 15.1: One to one work area separated by partitions (Source: Authors).


Figure 16.1: A ball pool for sensory stimulation (Source: Authors).

Figure 17.1: Opportunities to work on skills other than academics (Source: Authors).

Figure 18.1: A large window from monitoring room to assessment area (Source: Authors).

## Development of Evaluation Tools

The need to build a convincing argument in favor of the enabling parameters leads to the development of testing tools in the present research. Since the major concepts that are to be tested are well defined, standard questionnaires are developed based on design parameters to discover regularities of opinion amongst different group of people working for children with autism such as teachers, therapists and experts. The questionnaires include their past and present experiences as well as their future outlooks; this helped in producing multilevel quantitative data to support the hypothesis.

The research develops three testing tools to evaluate the design parameters; these tools are the environmental assessment, performance measure for children with autism and design parameter rating scale. Environmental assessment (EA) and performance measure for children (PMPA), validate the environment and performance inter-relationship, while design parameter rating scale

(DPRS) rates the importance of environment for children with autism. All tools are based on post occupancy evaluation studies in architecture, where existing buildings are evaluated for their functional performance and the resulting body of knowledge is used to design similar buildings in future (Zeisel, 2006, White, 1991).

The environmental assessment (EA) is a checklist of design parameters derived from the environmental design parameters for autism, and their presence is expected to improve educational performance. The performance measure for pupil with autism (PMPA) is derived to test the performance of children, in presence of the parameters. Design parameter rating scale (DPRS) is developed to assess the importance of the parameters. Using this scale, parameters are judged by consensus amongst the experts to be beneficial for children with and without autism.

## Survey to Validate Universally Pertinent Enabling Environment for Autism

The survey is carried out in naturalized environment that is familiar and comfortable for children reflecting long term performances rather than one time attempt, from the therapist and teachers, who understand children and their actions better. Survey is done in two stages, in the first stage data is collected from educational settings in USA to validate the formulated environmental design parameters and in second stage data is collected from various educational settings in India to understand cross-cultural dimension of design parameters. This paper limits its discussion to the survey and results from USA only. In USA, the EA and PMPA data is collected from seventeen classes (two preschool, five elementary, five middle and five high schools) in twelve schools. DPRS data is collected from twenty experts working with severely autistic kids and also from thirteen regular education experts.

The evaluation tools are pretested before the survey with a few autism teachers to understand the unintended side effects during survey. The comments are received and tools are revised incorporating the feedbacks from the participants. The techniques of survey and documentation include, interviews using standardized questionnaires, photographs, sketches etc. The representative samples in the survey comprise of:

(i) Educational spaces with low functioning children with autism
(ii) All age groups in schools, elementary, middle and secondary
(iii) Different type of educational settings from inclusive to specialized.

## Summarizing Results

The data collected from elementary, middle and high schools for autism shows strong correlation between educational environment and performance. Both environment and performance are assessed relating to the identified design parameters and their interdependence is clearly visible in figure-2. Some variations in the slope of graph profiles portray that although environment plays an important role, the performance is not solely dependent on it and there are several other factors affecting it.

The results are also compared for inclusive and specialized settings separately (figure-3), and it is observed that specialized settings are higher in environment than inclusive. Performance is highest in inclusive elementary but gradually declines in

middle and high schools, whereas performance in specialized setting improves throughout their school education. The environmental design parameters are ranked high by educational experts who work with autistic children as well as able-bodied children using 'design parameter rating scale' , 95% high school teachers, 92% middle and 92% elementary school teachers rated the design parameters as highly recommended on a five point scale. This confirms that the design issues are not only favorable for autistic kids but are also beneficial for all school children.

Universal consequence of the design issues to the educational environments is furthermore defined by the mean values of 'design parameter rating' by autism and regular education experts, that establish equilibrium between environment and the demand of all users with and without autism. Figure-4 illustrates this mean value as recommended value for design for all children with and without autism. When compared with existing environment in the USA, it is observed that existing schools comply with the recommended value 76% at elementary school level, 74% at middle school level and 70% at high school level. This is encouraging, but unfortunately this presence is because of the environmental interventions done by teachers in the autism classrooms and a few related areas, most of the other areas in the school buildings designed by architects do not show sensitivity to the needs of children with autism.

## Conclusions

Every child's behavior in autism is impacted differently, but all are first learners and second disabled. Enabling aspects for autism in the

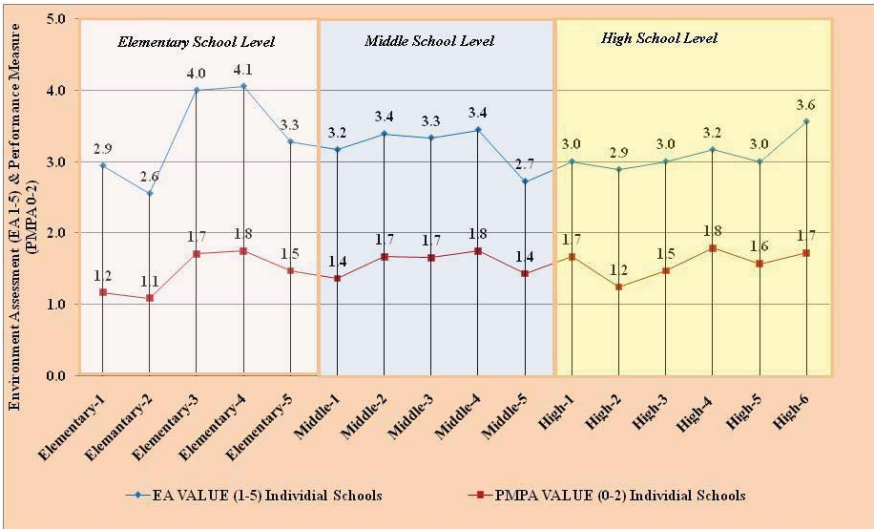


Figure 2: Environment and Performance Relationship in Elementary, Middle and High Schools (Source: Authors).

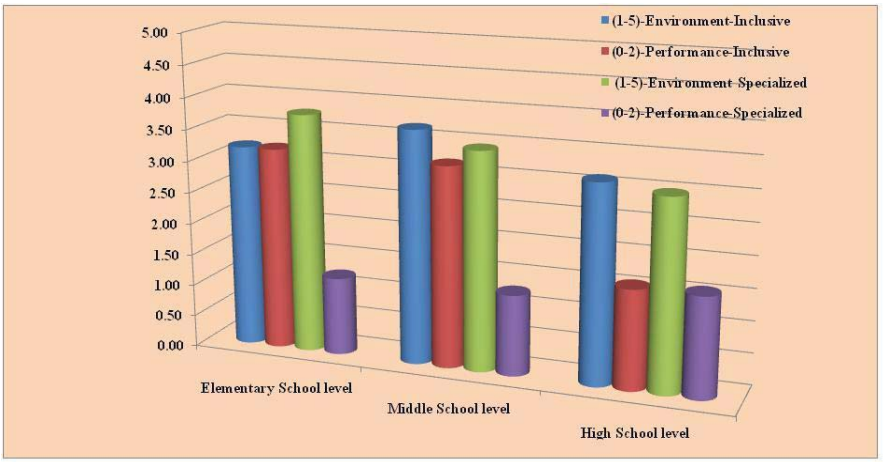


Figure 3: Environment and Performance Relationship in Inclusive and Specialized Schools (Source: Authors).

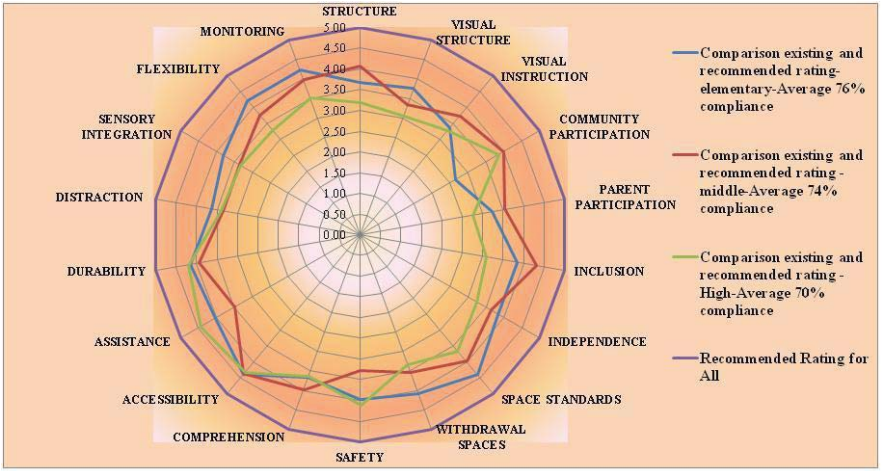


Figure 4: Existing and Recommended Design Parameter Rating in Elementary, Middle and High Schools (Source: Authors).

present study are identified based on what they can do, not on what they cannot do, to make it a successful experience.

The identified enabling aspects of the physical environment for children are reviewed by autism experts as well as regular education experts. All education experts rated the environmental design parameters very high, this confirms that the eighteen design parameters formulated

for children with autism are not only favorable for kids with autism but also beneficial for able-bodied kids. The experts' opinions are also analyzed for individual parameter that gave some thought provoking results (figure 5). When recommendations of autism experts for children with autism and regular education experts for able bodied-children are compared, it is observed that environmental design parameters that are generally expected to be helpful for conditions like autism and other developmental disabilities, are actually more beneficial for able bodied children. For example inclusion that is expected to be in favor of children with autism is rated higher for able-bodied children. Durability and maintenance is also rated as bigger issue for able-bodied children than children with autism. Safety and visual instruction are rated to be equally good for children with and without autism. Other parameters that are rated equally beneficial are visual structure and parent participation. The regular education experts have shown a little reservation about sensory integration and community participation, however, they have recommended them for able bodied-children as well.

Thus the environmental design parameters identified in the present research are universally beneficial, evidence based, open ended design stricture to conceive therapeutic environment for varied needs of children with autism. Following these design parameters designers and architects can design successful and enjoyable educational environment for children with autism that in long run will inspire a vision of a society that respects

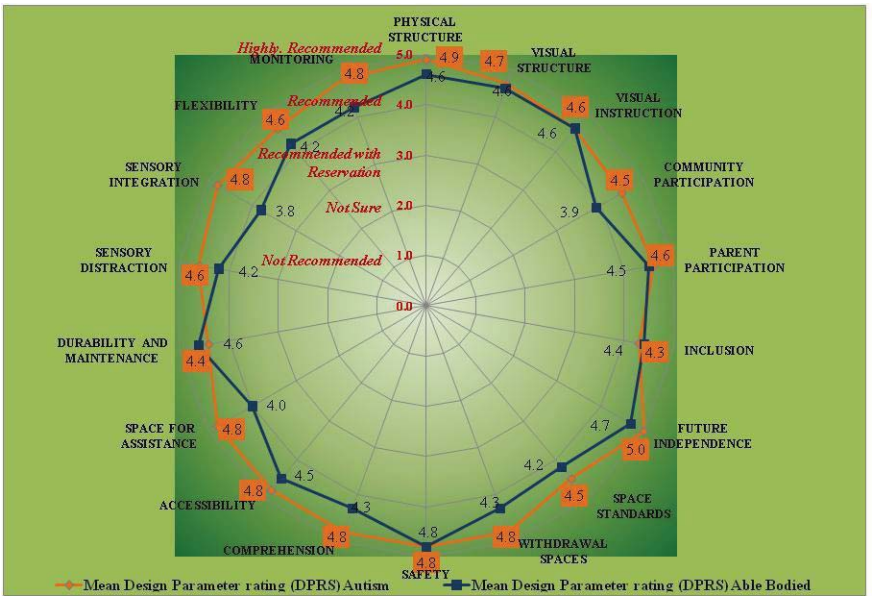


Figure 5: Recommendations of Autism Experts for Children with Autism and Regular Education Experts for Able Bodied-Children (Source: Authors).

and celebrates individual differences.

The future course of the study plans to develop detailed design guidelines that will present architectural solution for all spaces in the built environment from macro (location, site planning, landscaping etc.) to micro (building design, services, furniture, fittings, building materials etc.) level.

The current research explores the effects of physical environment on functional performance of children with autism; this could be extended in various directions in future, to better understand the relationship. The research has studied the overall impact of eighteen parameters in improving performance, future studies could further elaborate by studying effect of every individual parameter, on behavior of children with autism. The findings could be further strengthened by doing environmental interventions to study the impact of enabling environment on performance of children with autism. For developing countries, economic implications of the environmental design parameters could also be explored in future studies. Low cost and simple universal design solutions could be developed to help pupils with autism, using available resources, indigenous material, technology and skills.

The present study is a multi-disciplinary, multi-stage research that employs multiple research approaches in orderly way, to achieve the research objectives. The sequential progression in the study stands on accumulated body of knowledge, to produce enabling environment for children with autism. Using a research process, with pre-established foundations, it generates new evidence based knowledge, to design supportive, accessible and inclusive learning environment for all children with and without autism.

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## Notes

I. CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network released data in 2007 that found about 1 in 150; 8-year-old children in multiple areas of the United States had an Autism Spectrum Disorder.

II. Individuals with Disabilities Education Act (IDEA), United States of America, the federal legislation under which children and youth with disabilities receive special education and related services.

III. International Classification of Impairments, Disabilities and Handicaps, WHO 1980.

IV. American Psychiatric Association, (2000). Pervasive developmental disorders. In Diagnostic and statistical manual of mental disorders (Fourth edition---text revision (DSM-IV-TR). Washington, DC: American Psychiatric Association, 69-70.

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## Appendix

| Learning Behaviors in educational spaces as mentioned in the literature on autism education | Environmental design considerations based on teaching strategies and environmental interventions adopted by teachers | Design Parameters summarizing Environmental design considerations |
|---|---|---|
| **Impairment in social interaction** | | |
| Difficulty in understanding others feelings, emotions<br>Difficulty in experiencing 'self'<br>Difficult to get attention<br>Poor eye contact, lack social smiles and other nonverbal behaviors<br>Lack in social referencing<br>Lack social or emotional reciprocity<br>Difficulty in developing teacher/pupil relationship<br>Lack of peer friendships<br>Social situations are overloading<br>Remain physical withdrawn from people<br>Isolate themselves from social groups<br>Lack of social play and free play<br>lack imitation<br>Difficulty in turn-taking and waiting<br>Difficulty in problem solving<br>Difficulty in understanding social rules<br>May wander leaving their known environment<br>Unawareness to dangers | Provide one to one teaching spaces | Flexibility |
| | Provide smaller group settings while teaching with peers | Flexibility<br>Inclusion |
| | Provide space for parallel teaching | Flexibility |
| | Provide extra space for assistance in classroom and other areas | Assistance |
| | Provide structured teaching environment for order, clarity, and predictability | Physical structure<br>Visual structure<br>Visual instruction |
| | Provide space for independent working | Flexibility |
| | Provide large spaces to avoid overcrowding | Generous space standard |
| | Provide safe environment with secured boundaries | Safety |
| | Provide opportunities to withdraw from the group | Withdrawal spaces |
| | Increased quantity of facilities to reduce waiting | Generous space standard |
| | Provide opportunities for supervision for safety and collecting behavioral data | Monitoring |
| | Provide easy to maintain environment | Durability and Maintenance |
| | Involve other people around the child in teaching process | Parent participation<br>Community participation |

Table 1-A: Table-A: Relation between Learning behaviors, Environmental Design Considerations and Design Parameters (Source: Authors).

## Appendix

| Learning Behaviors in educational spaces as mentioned in the literature on autism education | Environmental design considerations based on teaching strategies and environmental interventions adopted by teachers | Design Parameters summarizing Environmental design considerations |
|---|---|---|
| **Impairment in communication** | | |
| Difficulty in receptive and expressive language skills<br>Range of communication impairment varies in children<br>Instrumental and literal language<br>lack of meaningful language<br>Stereotype and repetitive use of language<br>Repeating questions<br>Talking to strangers,<br>Difficulty in auditory processing<br>Get confused over too many words<br>Unable to generalize meaning<br>Around twenty five to forty percent remain mute throughout their lives<br>Face uncertainty and unpredictability<br>Unable to organize themselves in environment<br>Unable to understand and use non-verbal communication<br>Impairment to initiate or sustain a conversation<br>Do not understand social rules of conversation<br>Lack of make-belief play<br>Lack of social imitative play<br>Show frustration and behavioral outbursts<br>Unawareness to dangers | Provide environment to support multimodal means of teaching | Flexibility<br>Visual structure |
| | Provide spaces that are easy to understand | Comprehension<br>Structure |
| | Provide visual cues in the environment | Visual structure<br>Visual instruction |
| | Provide good acoustics in the teaching spaces | Sensory distraction |
| | Structured environment for order, clarity and predictability | Physical structure |
| | Provide space for individualized teaching for individual goals | Flexibility |
| | Space for employing specialists and therapist for parallel teaching | Flexibility |
| | Provide varied activities to sustain interest for long | Flexibility |
| | Environment to teach life skills and self-help skills | Future independence |
| | Provide spaces and equipments to teach vocational skills | Future independence |
| | Provide structured play areas that enables small group play and imaginative play with peers | Flexibility<br>Inclusion |
| | Provide spaces to use low-tech or high-tech communication devices | Flexibility |
| | Increase concerns for the safety of the children in the environment | Safety |
| | Provide opportunities to work with families and community | Parent participation<br>Community Participation |
| | Provide space and equipments for supervision and monitoring | Monitoring |
| | Provide easy to maintain and robust environment | Durability and Maintenance |

Table 1-B: Table-A: Relation between Learning behaviors, Environmental Design Considerations and Design Parameters (Source: Authors).

## Appendix

| Learning Behaviors in educational spaces as mentioned in the literature on autism education | Environmental design considerations based on teaching strategies and environmental interventions adopted by teachers | Design Parameters summarizing Environmental design considerations |
|---|---|---|
| **Restricted, repetitive and stereotyped patterns of behavior, interests and activities** | | |
| Driven to carry out an activity in a certain way<br>Have unusual, narrow, limited and repetitive pattern of interests and activities<br>Interests are mainly related to sensory stimulation<br>React with annoyance and anger when interrupted in their preferred activities<br>Difficult to divert or seek their attention<br>Difficult to sustain interest in a learning activity<br>Show strange behaviors when excited, bored, frustrated or in presence of a sensory stimuli<br>Preoccupations prevent involvement in other meaningful activities<br>Sometimes show marked talent in areas like drawing, music<br>Resistance to change<br>Adhere to nonfunctional routines and rituals<br>Display repetitive motor movements<br>Sometimes develop self injurious behaviors<br>Persistent preoccupation with parts of objects<br>Get obsessed with some objects in the environment<br>Box vision and do not attend to details | Provide an environment that engages in lot of meaningful activities during the day | Flexibility |
| | Provide structured environment for order and certainty | Physical structure<br>Visual structure |
| | Provide daily schedule supported by visual cues for day-today-structure | Visual structure |
| | Opportunities to participate in activities other than academics | Flexibility |
| | Provide calm and low arousal sensory environment | Sensory distraction |
| | Eliminate sensory distractions from teaching environment | Sensory distraction |
| | Employ multi-sensory cues to create interest in desirable activities | Visual structure |
| | Opportunity to experience sensory stimulations in appropriate ways | Sensory distraction |
| | Visual cues to help in problem solving | Visual structure |
| | Visual cues to help in generalization | Visual structure<br>Visual instruction |
| | Provide for safety in the environment | Safety |
| | Provide space and equipments for supervision and monitoring | Monitoring |
| | Provide easy to maintain and robust environment | Durability and maintenance |
| | Provide an environment that is easy to understand without complex details | Comprehension<br>Sensory distraction |

Table 1-C: Table-A: Relation between Learning behaviors, Environmental Design Considerations and Design Parameters (Source: Authors).

## Appendix

| Learning Behaviors in educational spaces as mentioned in the literature on autism education | Environmental design considerations based on teaching strategies and environmental interventions adopted by teachers | Design Parameters summarizing Environmental design considerations |
|---|---|---|
| **Sensory Dysfunction** | | |
| Over reactive and under reactive to senses<br>Show abnormality in perception to auditory, visual, touch, taste, smell and vestibular senses<br>Sensory dysfunction strongly affects interests and activities<br>Obsessive behaviors reduce learning opportunities and act as distraction for learning Inappropriate behaviors reduce interaction with peers<br>Get obsessed with fittings, furnishings and may use these incorrectly<br>Problem in coordination and balance,<br>Unaware of dangers in the environment<br>Hyperactive and under reactive to pain | Opportunities for using multisensory cues in activities and environment | Flexibility<br>Visual structure<br>Visual instruction |
| | Provide low sensory stimulus environment | Sensory distraction |
| | Opportunities to experience sensory stimulations appropriately in play areas and sensory rooms | Sensory integration |
| | Opportunities to use sensory stimulations as rewards in teaching | Sensory integration |
| | Opportunities to control sensory inputs for oversensitive children | Sensory integration |
| | Provide for safety in the environment against sensory obsessions | Safety |
| | Provide space and equipments for supervision and monitoring | Monitoring |
| | Provide easy to maintain and robust environment | Durability and maintenance |

Table 1-D: Table-A: Relation between Learning behaviors, Environmental Design Considerations and Design Parameters (Source: Authors).