



Designing For Children- A Comparative Study Of Various Design Elements In Montessori Schools And Kindergarten.

¹Nimmy Jojy, ²Ar. Vishnu P Prakash

¹B. arch Student, ¹Assistant Professor

¹Department of Architecture.

¹SCMS School of Architecture, Karukutty, Kerala, India

I. ABSTRACT

Designing for children is not same as designing for adults. This research shows the comparative exploration on common design factors and elements used in the design of spaces for children. The research intends to identify various case studies on Montessori schools and kindergarten from across the world and compare them in order to identify various design elements and planning technique that could appear promising and interesting when looked into from a child's perspective of design. These case studies are compared in terms of use of colors, materials, spatial layout, façade treatments, play yard design, relation between built and unbuilt etc.

Index Terms – *Designing for children, Design elements, Montessori schools.*

II. INTRODUCTION.

Designing spaces for kids requires careful consideration of their unique needs, interests and requirements in various developmental stages. A well-designed space helps with creativity, learning and a sense of security within children. Whether it is a bedroom, play area, classroom or recreational spaces the principles of designing spaces for kids have to be carefully considered to meet their interest and generate curiosity.

Nowadays various educational institutions for kids such as the Montessori schools and kindergartens takes various approaches and educational, models from the past in order to enhance the experience of children at these institutions. Model of Maria Montessori and Loriz Malaguzzi model are examples of two such educational models. While Maria Montessori's model was based on independence and autonomy, that of Loriz Malaguzzi was based on natural behavior, mood, relationships and interactions etc. (Laura Giral di)

According to these different models of education various factors must be considered for physical, emotional and social wellbeing of children in any spaces. These include: -

1. Better understanding of children's anthropometry for better and comfortable furniture and space design.
2. Complexity of space planning and layout.
3. Ease of way finding in schools.
4. Choice of materials.
5. Inclusion of nature and landscape as an element of design.

6. Relation between built and unbuilt.
7. Choice of colors.
8. Elements of playfulness.
9. Type of arrangement in classrooms and other outdoor elements. (Laura Giraldi)

III.NEED FOR THE RESEARCH

- Kids reacts to different spaces differently and hence capturing and understanding of design elements that capture their attention and interests is necessary for the kids to interact with those spaces.
- Considering the anthropometry of the children of different age groups is also equally important as children of different age groups has different anthropometric requirements. Any space designed without considering the anthropometry of children limits their access and at the same time results in loss of interests.
- Choice of colors generate different emotions and responses in children.
- Type of classroom arrangement and setups plays an important role in interaction and group activities.
- Choice of material and designing with respect to environment brings in a relationship between built and unbuilt.

IV.AIM

The aim of the project is to identify common design factors and elements used in the design of children's spaces, which could generate interest in children to interact and respond to different spaces, by comparing and analyzing different case studies of Montessori schools and kindergartens around the world.

V.OBJECTIVE

Objectives for achieving the aim includes:

- Finding different case studies of Montessori schools that meets the minimum requirements of the design elements needed for a comparative analysis.
- Ensuring that the elements of design and elements of playfulness used in the case studies are different as this could help in better comparisons between various elements and help in getting a better result and conclusion.
- Selection of case studies from different areas/countries for better comparisons.

VI.RESEARCH MEHODOLOGY

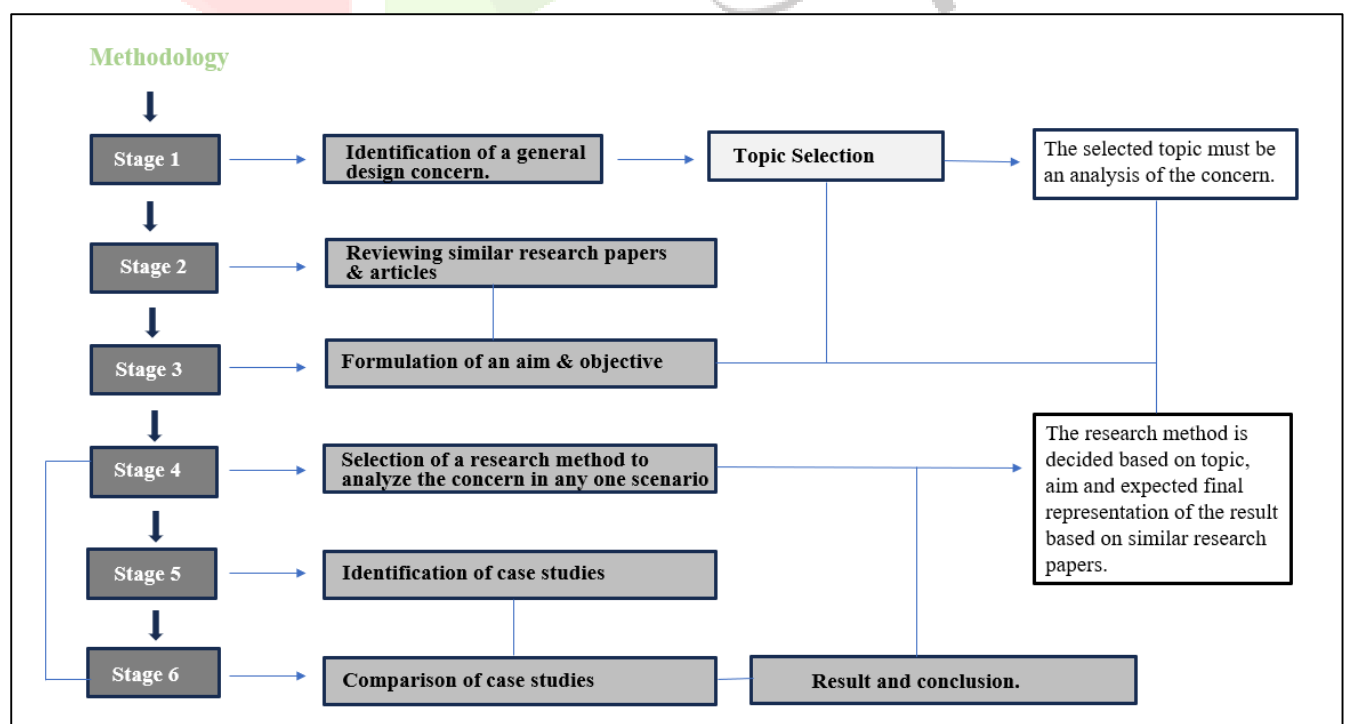


Fig 1:flow chart of research methodology.

VII.SCOPE

1. The research throws light upon the factors that has to be considered while designing schools for children.
2. Distinguishing between factors that attracts the attention of children of different age groups at educational institutions could be now easier.
3. Interaction between children and outdoor spaces could be explored and this could help in design of play areas, recreational spaces etc. at schools for children.

VIII.LIMITATION

1. This particular research could only take an approach of comparative analysis between different case studies due to the lack of time.
2. The comparisons could be done only between literature case studies and not live case studies due to time constraints.
3. Comparison is done without the use of any images due to copyright issues.
4. Different architects have different views about designing spaces for kids and hence generalizing a common typology could be difficult.
5. Difficulties in obtaining accurate data and measurements.
6. This approach of research is limited to educational institutions such as Montessori schools and kindergarten only.
7. The details of literature case studies are obtained from popular architectural websites such as arch daily and not from any peer-reviewed journals.
8. The conclusion of the research was formulated based on personal opinion.

IX.DATA COLLECTION

i. Natural environment as a playground.

In any structures dedicated to children it is important to establish a relationship between children and the nature. Our natural environment provides a large number of possibilities for imaginative play and explorations that cannot be offered by any other play yards. The natural contour, slopes, vegetation, boulders, water bodies etc. provides children with obstacles in their pathway which they will have to overcome on their own. The natural vegetation in any natural environment provides children with sufficient space and shade to rest and gather around. The curiosity generated by various natural features, insects, leaves, phenomenon etc. provides children with new possible learning opportunities that cannot be provided by any classrooms. (Fjørtoft)

ii. Macro Ergonomics. – classroom layout and seating arrangement.

Within the classification of ergonomics as physical, cognitive and organizational they are further subdivided as micro and macro ergonomics. Macro ergonomics mainly focuses on the spatial layout and planning of the classrooms. This includes classroom design and layout, arrangements of seating space, lighting and ventilation etc.

The design of classrooms in any educational institutions for children should be such that it must be able to engage the students and provide a happy and comfortable learning environment to them. Sitting in the same posture for a long period of time could result in back aches and other health issues in children. The seating arrangements and the classroom layouts should be such that they must be spacious and should provide the children with enough area to move around and engage in different classroom activities. The physical furniture arrangement should not isolate the children from one another and must promote peer interaction and group activities.

Adequate lighting and a sense of openness in classrooms helps the children to be less suffocated and distracted in their learning environment.

All these factors and design changes together helps in improving the communication, concentration and physical involvement of any kids in classrooms. (Dr.Rukshand Jabben)

iii. Color

Children have got a different set of color preferences when compared with adults. They tend to choose one color over the other based on its pleasant and attractive appearance and at the same time dislike other colors due to its unpleasant and unattractive appearance. This unlikeness results in a repellent behavior in kids from such colors. In a study conducted in a Nigerian Montessori school significant differences were observed in the choice of colors by age groups of 9 -12 and 3 -8 yrs. The choice of colors by children of age group between 3 to 8 years were ordered as red, tint, yellow, white, green, brown and black (Dr. O.N. Koleoso)

Colors can affect a person's experience in a space and his/her psychological functions. Studies have shown that colors can affect the performance of a person in any spaces. It was observed that colors such as yellow and red raised level of physiological activity in the body whereas colors such as green and blue generated a calming effect. Also, while the color red reduced the performance of children in class rooms green was considered as the best color for classroom walls. (Gilavand)

Researches and studies were also able to prove relationship and connection between colors and emotional memory. As a conclusion to their research, it was observed that kids were able to remember colored words more clearly and properly when compared with words written using ink. It was also observed that while the color red was more associated to anger in kids the color green and blue represented happiness and sadness respectively. Colors also help in formation and recollection of memory within kids and hence the choice of proper colors for the classroom walls, learning tools, and other objects used by the kids could help in significant improvement in their studies, concentration and daily activities. (Cipollone)

iv. Lighting

The indoor lighting has got a significant amount of influence on the learning abilities of kids in any educational environment. It plays an important role in learning performance of the children.

Studies have also shown correlations between student's cognitive developments, social behavior etc. with daylighting conditions in the classrooms. In any learning environment the purpose of lighting should be to enhance sight and vision by creating minimal discomfort. This can be achieved by both natural and artificial lighting systems. (Gilavand)

v. Way Finding

Way finding could be explained as the successful travel between destinations without getting lost in between. According to other researches the way finding abilities in children includes: -

- Inborn search tendencies.
- Path integration.
- Route following.
- Cognitive maps etc. (GARY L. ALLEN)

Different educational institutions such as Montessori schools and kindergartens could adopt certain techniques and practices that might help in fostering the way finding abilities in kids. These practices help the children to become independent at such young ages though it might require some assistance from parents and teachers.

Apart from these, many environmental design strategies could be also introduced to foster the way finding abilities in children such as use of well-defined paths, barriers to block ways and show the right directions, marked routes, distant landmarks, signs, maps etc. (GARY L. ALLEN)

vi. Relation between built and unbuilt.

Studies have shown that green spaces bring in positive effects in the life of children and helps in the significant reduction of stress along with satisfaction of their physical and mental needs. It generates a feeling of liberty and freedom within children. It is therefore important to have outdoor learning spaces in kindergarten and Montessori schools. Children must be able to walk around and touch and feel the environment in which they live in. An efficient design of classrooms for children must enhance the relationship between built and unbuilt by providing proper view of nature from the classroom. A relation between nature and classroom must be established through the design of spaces. (Mahya Sam)

It is therefore important to incorporate landscape and open courtyards in the design of educational spaces for children.

The outdoor classrooms and learning environment also helps in establishing a relationship between nature and children. This outdoor classroom could take the form of educational terraces, garden spaces, or even school yards where children could spend quality time by observing, interacting and experiencing nature. (Farhang Mozaffar)

Consideration of the following design factors are necessary for a better and efficient design of educational spaces for children. These factors are proved to provide much better experience to children in educational spaces and enhance their concentration and learning abilities.

Different space designs have different strategies to bring in positive developments and behavior in children. The same could be analyzed through the comparative study of case studies of Montessori schools and kindergarten.

X.CASE STUDIES FOR COMPARRISONS

A total of 6 literature case studies are chosen for the comparison of various design elements for children.

1)Name: Fuji Kindergarten

Location: Tokyo Japan

Architect: Tezuka Architects

2)Name: Yuecheng Kindergarten

Location: Beijing, China

Architect: MAD Architects

3)Name: My Montessori Kindergarten

Location: Vietnam

Architect: Nguyen Van Thu

4)Name: Nadanam Kindergarten

Location: Auroville, Tamil Nadu, India

Architect: Poonam, Shailaja

5)Name: MRN Kindergarten & Nursery

Location: Miyakonojo, Miyazaki, Japan

Architect: HIBINOSEKKEI; Youji no Shiro

6)Name: DPS Kindergarten

Location: Bengaluru, Karnataka, India

Architect: Khosla Associates

Comparison of these case studies helps in understanding and analyzing the design strategies used by them for efficient design and better experiences.

XI.COMPARITIVE ANALYSIS.**Table 1:comparative analysis of case studies.**

DESIGN ELEMENTS	CASE STUDIES					
	Fuji Kindergarten	Yuecheng Kindergarten	My Montessori Kindergarten	Nandanam Kindergarten	MRN Kindergarten & Nursery.	DPS Kindergarten
1)Materials used	-cherry wood slats in terrace deck. -Paulownia wood blocks for furniture and separation. -iron grid structure -light wood floors for classroom	- Glass walled corridors -Wooden handrails with steel railing. -single aluminum grille(interior)	-Steel (skeletal frame) -Trellis system of steel frame and wire mesh.	-Exposed brick -Hollow terracotta roofing. -Earthen pots used in filler slabs. -classrooms are plastered on the inside	- Glass(facade) -Timber flooring and furniture.	-Concrete blocks 10mx6m -Corrugated metal sheet walls-(corridors) -Terracotta screen and flooring

(continued)

Table 2:comparative analysis of case studies. (continued)

DESIGN ELEMENTS	CASE STUDIES					
	Fuji Kindergarten	Yuecheng Kindergarten	My Montessori Kindergarten	Nandanam Kindergarten	MRN Kindergarten & Nursery.	DPS Kindergarten
2)Colours used	-Wooden texture in floors and roof top.	-Red -Orange -Pink and its lighter shades (rooftop play yard) -Beige, white and wooden textures in the interior.	-White -Green (natural landscape) -Wooden textures (flooring)	-Earthy tone was created by use of exposed bricks. -Walls were plastered in white. -Pink, orange & green pillars.	-The colors used are green, blue and orange for the furniture. -floors, walls and cabinets were observed to be made of wood.	-Use of vernacular materials such as brick for jalls. -Red -Yellow -Blue -orange
3)Building facade	- Large sliding glazed doors.	-Glass walls	-Glass walls and vines	-Pillared corridors.	-Glass walls	-corrugated metal sheets
4)Spatial layout	-Oval shaped with randomly arranged structure to accommodate zelkova trees	-Irregular and free flowing layout around the historic structure at center.	-Exists as 2 separate blocks	-Exist as a continuous block around an open courtyard. -irregular	-Single L-shaped - Rigid structure	-Catusala (rectangular building with 2 central courtyard) -Rigid structure.

5) Seating arrangement	- Multiple chairs arranged around tables. - furniture blocks with a basic module of box as 300x300x300 which could be lifted and rearranged by kids.	- No orderly arrangement or isolations. - Multiple chairs arranged around tables. - All furniture were designed according to the anthropometry of the children.	- Multiple chairs arranged around square tables. - This arrangement appeared to be rigid and not free flowing. - An orderly arrangement was followed.	- Floors are used as seating. - There flexibility in arrangement.	- Multiple chairs arranged around rectangular tables. - This arrangement appeared to be rigid and not free flowing.	- The arrangement appeared to be rigid and not free flowing. - It was more similar to those in a traditional school.
6) Outdoor learning environment	- Terrace deck - zelkova trees	- roof terrace. - Courtyards - Stairs leading to courtyards.	- overhead walkway. - Garden area.	- Shaded courtyards. - Around neem tree.	- Fire exit stairs - Courtyard enclosed by L shape building.	- Not much possibilities Outside for learning.
7) Elements of playfulness	- Nets strung around the zelkova trees piercing the roof deck. - Hand rails around roof deck where children love throwing their feet through the gaps. - Slide and stairs to roof - Furniture blocks that can be rearranged.	- Stairs leading from courtyard to rooftop play area. - Rooftop play area with uneven surfaces creating small hills and contours which creates levels for children to climb on. - Tunnels at rooftop.	- Overhead Walkway at 2.7m - Garden spaces Are created between the two built structures for the children to learn, play and engage themselves in gardening activities. - Supports for vines are used for climbing.	- Walls and ceilings have playful openings which creates a play of light and shadow. - Large central courtyard.	- Natural environment is provided as children's playground - Landscape, sandpit, tunnels, pool etc. - There is bridge connecting the built structure with play yard which is located under a giant tree. - Water puddle	- Sandpit and brightly colored play equipments located at the central courtyards. - cuboidal platforms that are small and about 20 cm above ground. - These are small and painted in red for children to rest and interact.
8) Relationship between built and unbuilt.	- Zelkova tree within the oval shaped building	- Three courtyards which puncture The roof was	- Glass walls provide better view to the garden outside.	- The centre or the main focal point of the design is a	- Glass walls provide better view to the garden outside.	- View from classrooms was limited.

(continued)

Table 3:comparative analysis of case studies. (continued)

DESIGN ELEMENTS	CASE STUDIES					
	Fuji Kindergarten	Yuecheng Kindergarten	My Montessori Kindergarten	Nandanam Kindergarten	MRN Kindergarten & Nursery.	DPS Kindergarten
	piercing the roof deck -Large central courtyard. -Openable glass façade with view to courtyard	created around several old trees. -Visual connection with exterior environment and old courtyard house is established by floor to ceiling glass walls.	-The overhead walkway covered in vines and with trees on either side allows kids to experience nature from a higher level. -Direct view to vegetable garden.	large neem tree. -Plenty of landscape flows through the building. -All classrooms have got a visual connection with the central courtyard.	- Four big, mature trees were retained on the site at the center of the courtyard of the l shaped building. It provided better visual connectivity from classrooms.	-There wasn't much green spaces or landscape present. -The relation with natural environment was very limited. -The courtyard spaces only had few greeneries.
9)Lighting	-Large sliding glazed doors in façade (natural lighting). -Naked bulb lighting (artificial lighting). -Skylights. (natural lighting)	-Through use of courtyards. (natural lighting) - floor to ceiling glass walls. (natural lighting)	- Glass walls (natural lighting).	-Openings on the walls and ceilings, -Skylights. -Courtyard (natural lighting)	- Glass walls (natural lighting).	- vernacular terracotta jails. (natural lighting)
10)Natural environment as playground.	-Central courtyard. (However major natural elements such as trees, boulders etc. are absent).	-Absent. -With an old historic structure at centre the main play areas were the rooftop and courtyards.	-Absent. -The vegetable garden outside was created between buildings for the children to interact with nature.	-Present. - Courtyard at the centre with semi shaded spaces offered by the neem tree.	-Present -The courtyard formed by the l shaped building promoted the natural environment as a playground.	-Absent.
10)Way finding	-No specific techniques are used. -Traveling in a circular loop brings the children back to where they started.	- No specific techniques are used. - Traveling in an irregular yet continuous loop brings the children back to	- No specific techniques are used. -The kindergarten being set up in a much smaller area the kids could find	- No specific techniques are used. - Traveling in an irregular yet continuous loop brings the children back to	- No specific techniques are used. -The kindergarten being set up in a much smaller area the kids could find	- No specific techniques are used. -Way finding might appear confusing to children due to multi-

	-There are no dead-end spaces. -Wayfinding could be done using path integration.	where they started. - Wayfinding could be done using path integration.	their way back using path integration and inborn search tendencies.	where they started. - Wayfinding could be enhanced with the existing-coloured pillars.	their way back using path integration and inborn search tendencies.	storied structure and rigid form.
11)Separations between spaces.	-Rooms were simply divided by stacked up furniture. -There were no walls or clear distinctions.	-Courtyards. -Not separated by closed walls -Glass walls. -Furniture.	-Building exists as just 2 separate blocks separated by garden space & Overhead walkways.	-Walled separations.	-There were walled separations between classrooms.	-Walled separation between classrooms. -Jalis.

XI. DISCUSSION.

The data for comparison of case studies are obtained from personal observation, arch daily website and from websites of the respective design firms.

Upon comparing the colours used in various Montessori schools and Kindergarten it was observed that more focus was given to creating a bright and vibrant environment. Bright colours were used in rooftops, furniture, pillars etc. while the walls of the classrooms were left plain, painted white or left with the natural texture of the materials used. Use of colours as emotional memories were not followed by any of the case studies.

The building façade of 4 out of 6 case studies were done using glass as a material. Use of glass in the façade provides adequate lighting and at the same time provides necessary security and surveillance. It helps in monitoring the children during their outdoor play hours. Glass doors and windows also establishes a visual connectivity between built and unbuilt by providing a better view of the nature from classrooms.

The idea of pillared corridors was followed in the other two case studies of Nandanam Kindergarten and DPS Kindergarten. However visual connectivity with the outside environment was not fully established when compared with the other case studies.

Upon comparing the spatial layout of the building, it was observed that 3 out of the 6 case studies followed an irregular yet continuous spatial layout with the interplay of courtyards and open spaces. They believed in the concept of freedom, liberty and free flowing spaces for children that allows unfettered learning and play. On the other hand, rigid forms and spatial layout limits the movement of children. The spatial planning of DPS Kindergarten, My Montessori Kindergarten and MRN Kindergarten appeared to be too rigid, structured and oriented.

The outdoor learning environment was another major design factor which was missing in most of the case studies. Only Nandanam kindergarten and My Montessori Kindergarten had proper areas designated for outdoor learning. Through there were outdoor play areas as courtyards, rooftop play yards etc. There weren't any proper areas strictly designated for outdoor learning. Since there were flexibility in the usage of spaces in Kindergartens and Montessori schools possibilities to convert any outdoor areas into learning spaces was always open.

The element of playfulness was one such factor that was present in all the 6 case studies. Different case studies brought in different methods to bring in playfulness into the Montessori schools and Kindergartens. In most of the cases it existed as elements in rooftop play yards and courtyards.

The relationship between built and unbuilt was evident in all the 5 case studies except in DPS Kindergarten. In case of DPS Kindergarten view to the central courtyard was obstructed by walls. There wasn't any use of glass in the façade of the building to promote visual connectivity.

While in case of other case studies better connectivity was established through used of courtyards and glass façade. Better connectivity is important to enhance concentration and learning abilities. It is also important for the emotional and physical wellbeing of the children.

When it comes to lighting almost all the case studies preferred natural lighting techniques more over artificial lighting. Natural lighting emphasizes a connection with nature. It also offers visual comfort and reduces strain when compared to artificial lighting.

Another important factor that was missing in most of the case studies was the use of natural environment as playground. Though there were properly designated play areas for children one that included the true natural features of the environment such as the contours, slopes, water, vegetations etc. was the MRN Kindergarten and followed by Nandanam Kindergarten. Though other courtyards did offer play spaces in the natural environment many of the natural features were missing and appeared to be very much manmade.

Among the 6 case studies the case study with least connection with natural environment was the DPS Kindergarten. Natural features of the environment were totally not found in the play spaces designated for children.

As for the way finding techniques no specific techniques were used in any of these case studies.

For the classrooms 4 out of 6 case studies had got walled separations which isolated spaces from one another. Such separation limits connectivity and peer interaction. It generates a feeling of being trapped within a space with limited movement and freedom. Out of the 6 case studies only Fuji Kindergarten and Yuecheng Kindergarten believed in the concept of free-flowing spaces which was achieved by creating spaces with no walls or boundaries.

XII.CONCLUSION

All the conclusions of the research are based on personal opinion and comparison with the design elements.

Upon comparing the 6-case studies Fuji kindergarten and Yuecheng kindergarten appeared to be as an ideal model of Montessori schools and Kindergartens. Majority of the design elements for kids that was considered ideal for an educational institute for children was found to be present in these case studies. There was better connectivity with nature, free flowing spaces and continuity, elements of playfulness and better relationship between the built and unbuilt.

These case studies were then followed by My Montessori Kindergarten and MRN Kindergarten. Though majority of the design elements were present in these kindergartens they failed to create free flowing and continuous spaces for kids.

Nandanam Kindergarten could be also considered as an ideal model for Montessori schools and Kindergarten in terms of design techniques however, the main factor of elements of playfulness was limited in this approach of design. There were limited elements for the kids to explore though they succeeded in creating environment as a natural playground for children.

The case study that was considered to be as least appropriate as a model for Montessori schools and Kindergarten was the DPS kindergarten. Most of the design elements that was mentioned above in the data collection was found missing in DPS Kindergarten. This was the case study which was found to have least visual connectivity and relation between built and unbuilt due to the lack of landscape in design. This particular case study appeared to be as a model of traditional schools due to its obstructed views from classrooms and walled separations.

Also, upon comparing Indian case studies of Nandanam Kindergarten and DPS Kindergarten with the other 4 international case studies it was observed that the scenario in Indian context has to be much more

developed in terms of inducing elements of playfulness and visual connectivity into design of educational spaces for kids.

XIII.SUGGESTIONS AND RECOMMENDATIONS

1. Proper visual connectivity must be established between built and unbuilt by providing obstructing views of nature from the classrooms. The classrooms of children should not be covered by walls on or four side like in DPS kindergarten. There must be large openings and enhanced views of nature.
2. It is important to set up outdoor classrooms in any educational institutions for children. Outdoor classrooms environment helps in the holistic development, connection with nature and enhanced learning experiences of children.
3. One of the main factors that was missing in all of the case studies were techniques to improve way finding abilities in children. Establishment of different methods to foster the wayfinding abilities in children could benefit them in future.
4. There shouldn't be any walled separations in classrooms that limits access and movement between spaces.
5. Providing natural environment as playground in educational institutions helps in developing the imagination, sensory abilities and problem-solving skills in children. It also allows them to establish a close relationship with nature.

XIV.REFERENCES

1. Assael, David Basulto and David. *Arch Daily*. march 2008. web. 18 February 2024.
2. Cipollone, Elèna. "THE INFLUENCE OF COLOURS ON EMOTIONAL MEMORY: HOW COLOURS CAN IMPROVE LEARNING IN PRIMARY SCHOOL CHILDREN." *Italian Journal of Health Education, Sports and Inclusive Didactics* (2022). web.
3. Dr. O.N. Koleoso, Prof. B.O. Ehigie ,Dr. K.O. Akhigbe. "Colour Preference among Children in a Nigerian Montessori School." *Mediterranean Journal of Social Sciences*. (2014): 325 - 332. web.
4. Dr.Rukshand Jabben, Gul Hina Butto,Khizra Fatima,Moatter Anwer. "How effective is implementing macro ergonomics for children in their early years in school? A qualitative study at Montessori in Karachi." *Russian Law Journal* (2023): 3069 - 3076. web.
5. Farhang Mozaffar, Seyedeh Somayeh Mirmoradi. "Effective Use of Nature in Educational Spaces Design." *Organization,technology and management in construction*. (2012): 381-392. web.
6. Fjørtoft, Ingunn. "The Natural Environment as a Playground for Children:The Impact of Outdoor Play Activities in Pre-Primary School Children." *Early Childhood Education Journal*, Vol. 29, No. 2, Winter 2001 (2001): 111-117. web.
7. GARY L. ALLEN, RANI LUEDER, AND VALERIE RICE. "RUNNING AHEAD: CHILDREN AND WAYFINDING." Rani Lueder, Valerie J. Berg Rice. *Ergonomics for children designing products and places for toddler to teens*. Milton Park: Taylor & Francis Group, LLC, 2022. 861 - 885. web.
8. Gilavand, Abdolreza. "Investigating the Impact of Environmental Factors on Learning and Academic Achievement of Elementary Students: Review." *International Journal of Medical Research & Health Sciences* (2016): 360 -369. web.

9. Laura Giraldi, Elisabetta Benelli, Marta Maini, Francesca Morelli. "Kids at Preschool. Designing products and wayfinding systems to enhance kid's skills, facilitating wellbeing through communications." Ho, Amic G. *Advances in Human Factors in Communication of Design: Proceedings of the AHFE 2019 International Conference on Human Factors in Communication of Design, July 24-28, 2019, Washington D.C., USA*. Cham: Springer Nature Switzerland AG, 2019. 141 - 150. Web.
10. Mahya Sam, Maryam Kouhirostami. "A Critical Review on the Impact of Combining Outdoor Spaces and Nature with Learning Spaces on Students' Learning Ability." *Grid architecture, planning and design journal*. (2020): 272 - 290. web.

