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Original Article

Montessori-inspired Interiors: Designing spaces for Early Childhood development.

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Abstract: -

The research has investigated the importance of interior design in creating an indoor environment within a nursery and its direct impact on the self-development of toddlers. It emphasizes that the physical setting should actively contribute to fostering independence, confidence, and comfort in early childhood. This study confirms the hypothesis that interior design makes an important contribution to supporting educators in addressing the spatial needs of Montessori environments and highlighting the interrelationship between design principles and educational philosophy. By doing so, it identifies practical guidelines for designers to configure classroom spaces in ways that enhance the learning experience and general well-being of children. This research identifies that most classrooms within nurseries lack an authentic Montessori-friendly environment but instead this approach is employed by using it only in toddler's activities. To address this emerging issue, the study insists on clear interior design guidelines to be developed for purpose-built nursery facilities that conform to Montessori philosophy. Such guidelines are necessary for all design elements and will address zoning, circulation and movement, lighting, furniture and shelving, flooring, and incorporation of natural elements in ensuring that the physical environment actively promotes Montessori philosophy. A mixed-method approach was adopted, combining qualitative and quantitative techniques. Data was collected through questionnaire with nursery teachers and mothers of toddlers, added to an observation study, and complemented by a benchmarking analysis of Montessori-inspired nurseries at local, regional, and international levels. Results show that Montessori principles can be successfully interpreted in the form of interior design guidelines, which would enable classrooms to foster independence, responsibility, and self-confidence while ensuring safety and comfort. Recommendations emphasize the importance of cooperation between interior designers and educators in creating an environment that will actively boost Children's development and make the physical space a partner in the learning process.

Keywords: *Montessori principles; Interior Design Guidelines; Toddler's Comfort; space configuration; early childhood; nurseries' design; children's development.*

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1. Introduction:

1.1. Background:

The interior environments of nurseries are not merely functional spaces; they are foundational spaces that play an important role in the early development of toddlers as they influence the development of children's self-esteem, confidence, independence, comfort, and development [1]. Considering the important role of interior environment in the development of children, it would be important to discuss how such space can be developed in an interior design framework that aims to develop these aspects in children. In this respect, a prevailing model known as the Montessori approach was developed in the early 20th century by Maria Montessori, a leading figure in early childhood education. In Montessori's philosophy, great importance was given to the integration of education and care, which encouraged spaces for children that allowed and promoted discovery and independence [2]. A crucial component of Montessori's theory revolves around the idea of the child's "sensitive periods", or different stages in a child's early development in which toddlers show a strong impression on certain features of the interior space where they spend their day [3]. Each sensitive period is marked by young children showing clearly spontaneous interest in certain aspects of life around them which are most apparent in their first six years of life. [4]. These stages, which exist in the early six years of life, serve to emphasize the need for well-designed interiors. Understanding these phases of a child's development highlights the motivation behind this study, that would aim to gain insight into how Montessori-inspired interior spaces can be created to benefit the development of children when considering their sensitive periods.

1.2. Research Motivation:

Nurseries and Kindergarten environments are crucial for the overall development of the child; however, in Bahrain, the regulation was primarily focused on the educational programs and activities being conducted, and not the space used for educational purposes. UNESCO circular emphasized that kindergartens and nurseries in Bahrain are governed the umbrella of one authority to maintain unity in educational requirements and daily programs [5]. However, the Ministry of Education [6] and the Kindergarten License services at Bahrain National Portal [7] further highlighted that at present, there is no standard for the interior design for kindergartens in the Kingdom, stating that this is determined either by the operators, contractors or architects. This is an important aspect that requires study to fill the gap between the regulations for educational requirements and spatial environment design. This study seeks to align the regulated educational requirements for Bahrain with spatial design that cultivates

independence, confidence, and overall developmental success for toddlers through the conceptualization of a typical classroom fully adhering to the Montessori design principles.

1.3. The issues and objectives:

Nevertheless, despite the ubiquitous application of the Montessori educational method around the globe, many childcare facilities and preschools classified under the umbrella term "Montessori" fail to embody a rigorous adherence to the spatial and environmental principles defined by the original thoughts of Maria Montessori, specifically due to a lack of patent protection and regulation in the application of the term "Montessori." [8] . As fundamental principles to the Montessori method point to interior environment as a crucial element in providing for autonomy, freedom of movement, use of the senses, and self-directed education, it has been found that instead of emphasizing environments that meet these principles, current application favors pedagogical approaches influenced by Montessori methods over appropriate interior design principles for sustained Montessori implementation [9]. This is specifically true for facilities utilizing converted structures that do not primarily belong in the education sphere. There is a remarkable scarcity of empirical research regarding the level and application of environments that apply the term "Montessori" in an accurate and meaningful manner. In response, the main purpose of the proposed study is to examine the application process of Montessori education philosophy in interior spaces reserved for early childhood learning environments, with a special emphasis on the space and environmental attributes that determine a true Montessori friendly environment. The proposed study will attempt to close the difference that exists between education theory and interior design applications by analyzing the way in which Montessori philosophy is implemented in the designed layout of nursery and preschool spaces through a set of measurable interior design parameters. By examining the most important interior design parameters, namely space zoning, circulation, lighting sources, [10], accessibility to shelves and child-size furniture, floor covering, and natural element integration [11], the proposed study will have the ability to determine the extent to which the current Montessori-identified learning spaces correlate with the desired education goals. The proposed study will also have the capability to develop a set of measurable interior design guidelines that will assist architects, interior designers, and educators in the design and adaptation of preschool and nursery spaces in terms of authenticity, effectiveness, and alignment with Montessori education goals [12].

2. Literature review:

2.1. Theories, concepts, and previous studies:

In the Montessori method, the child is the center of the learning process with a thrust on freedom in a classroom environment. The key aim of this method in the case of toddlers is to allow them to discover their potential by providing freedom within the interior environment surrounding them, that it is designed in a manner to consider the developmental and learning requirements of children [2]. Guided by this approach, toddlers are oriented to boost their self-confidence skills to become socially responsible and active citizens in the future. Recent Scholars proves that particularly during early childhood, every stimulus (sensory design element in the interior environment) becomes a discovery and learning experience that constitute the fundamental parts needed for the growth of sane and emotionally balanced toddlers [13]. Added to that, Maria Montessori stated that when the interior environment is well designed and divided into zones that offer varied experiences for the toddlers, who can reach multiple levels of engagement and learning [14]. On that basis, the core of the Montessori approach lies in creating an interior space thoughtfully designed to be functional. This design supports the toddler's development milestones, privacy, as well as the educational requirements for children's education [15]. Motivation for this study derives from the acknowledgement that nursery environments are more than mere physical surroundings, instead, they are developmental landscapes for toddlers. By uncovering the underlying principles of designing Montessori-inspired classroom interiors, this research aims to reveal the potential of space planning, sensory, and zoning use in developing confident toddlers by designing a confident interior space.

2.1.1. Spatial Design & Child Development link in Montessori environments

In Montessori contexts, the current literature seems to converge on the notion that spatial organization plays an active role as a pedagogical mediator in the autonomy, mobility, and socio-emotional development of children. The design variables co-contribute along with other environmental factors in improving the toddlers' developmental outcomes.

a) Environmental order

Studies investigating Montessori environments consistently emphasizes the importance of order within the interior space as a key factor in supporting children independence and exploration [16]. Recent researches prove that clearly defined and ordered classroom environment is a key developmental tool, as a predictable environment allows toddlers to independently explore their environment and engage in purposeful activity without needing to rely on adult support [17]. Across a range of studies, ordered classrooms have consistently been

associated with safe movement, and exploration [16].. These findings suggest that order is a key developmental support that allows children to interact effectively, confidently, and safely in Montessori environments.

b) Freedom & Responsibility

Various scholars have demonstrated that freedom and responsibility are considered as primordial concepts in Montessori environments. Recent research literature revealed that children's sense of responsibility is promoted by their freedom to access playing materials shelves on their own [18]. However, recent scholars validated the importance of understanding that the freedom in a Montessori classroom is restricted within clear boundaries set by the teacher [19]. Thus, all findings point to a general understanding that structured access to objects promotes toddlers' autonomy and responsibility.

c) Self-directed learning and self-discipline

Throughout the literature, the common consensus validates that Montessori approach promotes self-directed learning and self-discipline [20]. Research on toddlers' cognitive and behavioral development has continually demonstrated that the independent activity encouraged by the Montessori method boosts their problem-solving and persistence skills [21]. Overall, the literature appears to demonstrate that the Montessori method promotes children autonomy and self-directed learning skills.

d) Active movement & circulation

Across the literature, it has been validated that the spatial design of Montessori 'Nido' environment plays critical role in boosting toddlers' active movement and circulation [4]. Studies on interior design and ergonomics demonstrate the significance of open space and fluid circulation in facilitating the movement and mobility of toddlers [22]. Collectively, these studies emphasize that the fundamental principles of the Montessori method can be addressed through an interior design layout.

e) Sensory discrimination & Observation

Recent studies validated that rich sensory environment greatly improve toddlers' capacity to classify, sort and interpret learning materials using tactile, visual, chromatic, and auditory senses, and proved that a high sensory atmosphere fosters conceptual growth faster than a conventional learning environment [23]. At the same time, other literature verify that observations foster creativity and self- expressions within a familiar interior environment [24]. Collectively, studies demonstrated that the Montessori approach is not a distinct principle but

a unified whole that integrates environment, order, freedom, movement, and sensory experience.

In summary, literature on Montessori environments consistently reveals the role of spatial design to boost children's autonomy, mobility, and socio-emotional development. Order, freedom within boundaries, self-directed learning, circulation, and sensory experiences are revealed as interconnected principles that promote the independence and creativity of the child. This consistency supports the holistic nature of Montessori design. However, most literature appears descriptive and context-specific, with questions remaining about the universality and long-term developmental effects of the spatial features.

2.1.2. Message-Environment Relationship:

More recent research investigated the impact of classroom layout on toddlers' behavior and development. Rather than considering the classroom interior environment as a physical space, researchers have proved its communicative role in shaping autonomy, attention, and well-being. Literature proves that order and calmness in classroom design supports children's attention, autonomy and engagement [25]. Scholars highlight that designing a classroom layout according to Montessori's approach promotes toddlers' well-being, because of the communicative role of the environment, which conveys order, calmness, and autonomy.

In addition, the physical layout of the classroom has been found to impact peer relations and collaborative play. Defined activity zones and strategic placement of learning objects promote efficient task transition, reduce distractions, and foster constructive social interactions [26]. Such resemblance with the concept of "freedom within limits" as described by Montessori reflects the direct role of interior design in facilitating toddlers' social development through smooth circulation and constructive peer interactions.

On the other hand, theoretical approaches such as "Maslow's hierarchy of needs", emphasize the role of safety and belonging in the foundation of emotional development [27]. Literature clearly connects the creation of safe, familiar, and supportive environments with children's capacity to develop social relationships, thus proving the link between Montessori approach and interior environments that promote security and autonomy.

Ultimately, these findings suggest robust consensus that classroom environments may boost children's developmental skills. Literature validated that spatial design shall be characterized by order, freedom of movement, and safety which converge together to support toddlers' autonomy, social connection, and emotional well-being.

Table (1): link between toddlers' Message and Environment [28]

Toddlers' affirmation	Interior Environment Response
The classroom is comfortable and safe	• The room is partitioned appropriately, and the shelves are set for optimal angles of views. • A child-friendly table, chair and cozy rug are provided • There is optimal, comfortable space for movement both inside and outside the classroom. • No child is without their own space where the child could feel safe and secure. • The classroom is kept clean and orderly.
I am a valued member in this space	• Images and materials depict children's families, languages and reflect their culture. • Areas are designated for the storage of children's work. • Children can see their work displayed at different places in the classroom.
I am able to share my belongings with my peers.	• The classroom is designed to allow toddlers to collaborate in small groups. • Materials are shared collectively by the group of kids. • Spaces are designed for children to play cooperatively.
I am able to find all my requirements.	• Everything is very accessible to children and kept organized. • The playing materials are easily accessible.
Playing here could be interesting	• The classroom interior environment is attractive and visually pleasing.
I can access my essentials	• Materials in storage have designated locations clearly marked, and items are returned to the shelves after use.
I am trying to explore new activities	• Children and teachers can interact with each other individually or in groups. • The environment is conducive to promoting interaction among toddlers.

The results obtained from this study suggest that interior space of a classroom is crucial in decoding the implicit messages directed by toddlers towards their development [28]. Spatial organization and comfort, along with safety, are factors in creating an emotionally secure learning setting. Visualization and display of toddlers' artwork with nature materials and local are significant in instilling a sense of belonging and self-value [29]. The availability, accessibility and proper arrangement of the learning materials are important in boosting toddlers' independence and responsibility, while sharing and interaction spaces are vital in developing an aspect of exploration and engagement. The visually attractive and interaction-driven interior spaces further increase the qualities of curiosity in toddlers, supporting their emotional and social skills.

2.1.3. Spatial Design Features Within Classroom Environments

Recent studies have proved that learning outcomes have been directly linked to the interior design of the education environment. For instance, contemporary publications confirmed that learning outcomes could be enhanced by 16% when refining the classroom design, hence emphasizing the importance of such environmental factors [30].

In terms of educational outcomes, literature highlights the significance of lighting, ventilation, flooring, color and openness in the development of toddlers' socio-emotional, self-confidence, communication skills, and independence [31]. Referring to studies carried out on lighting, natural lighting improves the engagement of toddlers, while artificial lighting enhances task-related performance [32]. Multiple lighting sources aid to maintain the toddlers' attention, prevent monotony, and convert dark areas into more inviting areas. [33]. Studies on ventilation are associated with human well-being and cognitive performance. In this regard, natural ventilation is considered effective despite its mechanical constraints that need proper maintenance to avoid physiological effects [34]. Research has been conducted concerning windows and doors to validate their crucial role in creating visual connection with nature. Insulating materials have also been applied to reduce noise and heat loss to create openness and safety [35]. Similarly, Literature proved that color schemes and wall coverings impact emotional stability and creativity of children [36]. Breathable and humidity-resistant finishes are also crucial, as they increase toddlers' comfort, thus emphasizing the aesthetic aspect of Montessori spaces [37] . Studies on Flooring finishing emphasizes safety and mobility aspects. Slip-resistant, easy-to-clean, and reflective floor materials are important for toddlers' comfort and hygiene [38]. Parquet flooring is associated with ergonomic and aesthetic benefits, stimulating children's exploration and discovery skills [39]. Collectively, these studies prove that environmental factors are not only functional but also pedagogically significant. Design elements such as openness, lighting, ventilation, color, and floor coverings, improve children's cognitive and socio-emotional functioning, which supports the Montessori method.

2.1.4. Montessori Approach Link with Spatial Features

Recent studies related Montessori principles to spatial elements, including natural lighting, greenery, movable furniture, and modular spaces [40], [41]. These studies showed that Montessori interior space shall be flexible, functional and organized, to guarantee toddler's independence in space.

Table (2): Concepts reflecting the Spatial aspects in Montessori Education [42]

Concepts	Designing spaces for Montessori Education
Openness	Spaces that feel inviting and stimulating, with clear, simple layouts and easy access to educational materials for exploration.
Variation	Areas designed for both group and individual activities, offering different zones and choices to suit personal preferences and learning styles.
Flexibility	Environments that allow freedom of movement and choice, adaptable to each child's needs, and encourage hands-on learning experiences.
Relevance	Spaces tailored to children's height, age, and culture. Places they can trust, feel safe in, and where their personal needs are met.
Naturality	Real-life settings that foster responsibility and connect children with nature, using natural materials and offering environmental experiences.

The study concluded in table (2) showed that there is a tangible relationship between the application of design principles based on Montessori ideas, which leads to development and educational outcomes. Openness in design allows for exploration, autonomy, and directions, as well as a display of educational objects in the classroom. Variability in spatial zoning allows toddlers to work either independently or in groups, which is beneficial for cognitive and socio-personal development. Flexibility allows children to move freely, which leads to autonomy and experiential education. The sense of relevance, derived from age-appropriate designed space, leads to trust, security, affiliation, and naturality, which allows children to feel more related to interior space, leading to responsibility, environmental, and sensory development in toddlers.

The results have confirmed that the spatial design approach in line with the values of Montessori is an active factor in education, which fosters holistic development through the integration of autonomy, interaction, and effective learning in the built environment.

Throughout these studies, it has been proven that the Montessori method is perceived as the integration of spatial components validated by various research methods. Quantitative research proves an improvement in learning results, while other studies show behavioral and social aspects. Ergonomics and environmental studies show aspects related to health and comfort. All these studies prove that Montessori-inspired interior design is characterized by its ability to integrate educational philosophy with design strategies, which can support the development of autonomous toddlers in a healthy and holistic way.

3. Methods:

This research paper has made effective use of the convergent mixed method to evaluate the interior design guidelines of a Nursery environment adopting the Montessori approach. The application of the mixed research methods was also justified by the need to triangulate the results, to ensure that the qualitative assessment of spatial environments is consistent with quantitative survey results. Recent scholars emphasized that the application of both qualitative and quantitative methods validate more the research findings, especially regarding their practical applicability [43], [44].

Quantitative data was collected by conducting a questionnaire targeting teachers and parents, to explore the importance and impact of Montessori design elements. While the qualitative data was gathered using structured observation. A benchmarking of nine case studies against Montessori standards is done to give more context to the findings.

When triangulated, the three used methods, common and distinctive features, are highlighted to provide evidence-based design guidelines for Montessori toddler environments [45].

3.1. Questionnaire Methodology

3.1.1. Questionnaire Objectives

The questionnaire was aimed at assessing the impact of nursery classroom environment in enhancing children's autonomy, comfort, safety, and development. Particularly, it was intended to evaluate the alignment of the classroom design to the Montessori theory, capture the adult insights and opinion on the impact of spatial design on toddlers' skills, and highlight the strengths and gaps within classroom environment to inform future design practices [46].

In this research, the questionnaire method was selected because it provides consistent data for a large number of stakeholders interviewed, facilitating systematic comparison among groups. Because children cannot clearly articulate their spatial needs, adults' proxies including teachers and parents, are selected to be most relevant respondents. This method has been validated by recent studies in which educators and caregivers were considered as expert observers in children's interactions with their environments [47].

3.1.2. Questionnaire Design

A structured questionnaire was prepared and conducted via Microsoft Office Forms to gather data from five nurseries located in the Kingdom of Bahrain. The process of designing the included three stages: first, drafting the questionnaire based on existing literature on early-childhood interiors and referring to Montessori theory; second, conducting a pilot study to ensure its importance; and finally, sending the refined version of the questionnaire to the participating nurseries via WhatsApp chatgroups. The collected data was compiled and analyzed to ensure consistency and reliability.

3.1.3. Questionnaire Dimensions

In order to have a comprehensive understanding about the interior environments in a classroom setting, the questionnaire was targeting six core aspects related to activity's types provided in nurseries' classrooms and their impact on the toddlers' development. The questionnaire dimensions are based on topics discussed at literature review section, thus creating consistency between theory and research methods. Recent research has clearly proved the significance of comfort and circulation in promoting toddler's active movement, autonomy and self-confidence through self-learning, sensory activities in promoting creativity, and accessibility of shelves in boosting responsibility in a free space, safety impacting emotional stability, observation in promoting interaction with peers, and other aspects of the environment such as

lighting, ventilation, and aesthetics in endorsing holistic design. These parameters cover the fundamental aspects of the Montessori approach in ensuring movement, freedom, order, and sensory activities in the classroom.

Table (3): link between questionnaire factors and Montessori features

Questionnaire factors	**Evaluation Rationale**	**Montessori Feature Translation**
Q1. Comfort (Active movement)	Evaluate whether classrooms facilitate circulation and physical comfort, supporting the development of motor skills and reducing frustration.	**Circulation & movement:** Freedom to move within the classroom
Q2. Independence & Self-confidence (Self-directed learning/self-discipline)	Assess if support is provided for toddlers in making choices and developing self-discipline, autonomy, and self-esteem	**Zoning:** Classrooms divided into zones to encourage self-directed learning.
Q3. Activities (Sensory discrimination)	Analyzes the range of activities that sharpen perception and cognitive abilities through sensory experiences.	**Openness:** Sensory-enriched and open activity spaces.
Q4. Accessibility to shelves (Freedom & responsibility)	Assesses toddlers' ability to use materials independently, promoting responsibility and autonomy.	**Shelving:** Low, open, and accessible to children.
Q5. Safety (Observation)	Ensures furniture and designs minimize harm and promote safe exploration and observation	**Furniture:** Child-scale, safe and stable furniture.
Q6. Interior design factors (Environment)	Evaluates how space elements such as light, greenery, and interactive flooring impact mood, attention, and interest	**Spatial Design components**: Incorporation of Greenery, Light, and Interactive flooring.

3.2. Observation study methodology

3.2.1. Participants

The observation study included around 50 children, with an average of 10 toddlers in each nursery, with ages ranging from one to four years. The toddlers were registered in five nurseries in the Kingdom of Bahrain. The nurseries were chosen based on similar characteristics, as identified in the questionnaire method, also reasoning that the interior design of the classrooms is adhering to Montessori principles. The nurseries were also chosen because of their willingness to cooperate with the study and their representativeness as typical early-childhood institutions, hence presenting ecological validity.

3.2.2. Observational Settings

The observation is conducted in realistic settings within the regular working hours of the nursery. The duration of each observation period was around two to three hours. The sessions were done during pick activity periods of the day, for two weeks. This ensured that the observer was able to notice toddlers' activities within different age groups. This proves that observations were based on consistent patterns of behavior rather than isolated occurrences.

3.2.3. Observation procedure

To ensure fairness, the researcher took the role of an outsider observer, using checklists, standardized observation sheets, and time-sampling frameworks. These tools facilitated the record of data relating to environmental settings, child behaviors, and the frequency of child engagement with creative corners and play materials in a consistent way to avoid observer bias.

3.2.4. Observation measures

Observation factors were taken from Montessori principles retrieved from literature review section, which reflects toddlers' behaviors. These aspects are:

a) Comfort: freedom of circulation.
b) Independence: autonomy to access materials.
c) Creativity: participation in creative activities.
d) Utilization of space: efficiency of each zone.
e) Interaction with furniture: engagement with Child-Scale furniture.
f) Lighting and mood: the impact of light on children's activities.
g) Interactive flooring: the toddlers' interaction with the colorful and patterned floors.
h) Indoor plantation: the toddlers' interaction with the natural elements.

3.3. Benchmarking Study Methodology

This comparative analysis was undertaken at local, regional, and international levels to analyze nine classrooms interior spaces of nurseries adopting Montessori theory. The nurseries were chosen for three main reasons: firstly, the nurseries' commitment to the Montessori model ensures methodological consistency; then, the availability of data through published materials on official websites eased the comparison; and lastly, representing various geographic contexts helped identify different design elements in various environmental settings.

Unlike case studies, where the focus is to study the details of a particular case, the use of the benchmarking method helped the study to identify efficient designs features across multiple nurseries and set design standards that can be used to promote toddlers' autonomy, safety, and sensory development.

3.3.1. Case Studies Selection criteria

The criteria that were used to choose the nurseries were informed adopting Montessori principles. All nine examples of nurseries had to maintain similar classroom area having approximately ten toddlers each. The age group of the children had to fall within the category of one to four years. Moreover, only nurseries with publicly available information on their

interior environment were taken into consideration. This ensured that the institutions selected for the study were comparable in terms of size and approach to pedagogy, while at the same time providing sufficient diversity to enhance the validity of the benchmarking analysis.

3.3.2. Analysis Variables

The benchmarking analysis provided in-depth assessment of design features in each nursery in accordance with the Montessori design guidelines. The benchmarking analysis assessed key dimensions such as zoning, which refers to the partition of the classrooms into areas to encourage self-directed learning; lighting, which entails the proper utilization of natural and artificial lighting to impact the children's attitude and senses; furnishing, which requires the utilization of accessible, child-scale, safe and furniture; circulation, which necessitates freedom of movement and spatial configuration to boost independence; and greenery, which refer to the incorporation of plantation. Other variables considered were interaction with floor surfaces, and accessibility of materials. This analysis was conducted based on the understanding of the fundamental value of the Montessori philosophy in terms of safety, comfort, independence, and sensory exploration of the toddlers. Furthermore, the above-identified variables create an observable measure of the behavioral response of toddlers.

3.3.3. Benchmarking purpose

The purpose of this analysis was to identify the level of adaptation nurseries to the Montessori design elements. At the same time, it was also important to determine the effect of these elements on toddlers. The use of the Montessori method in the analysis shows how theory is applied in practice. The results of benchmarking can be adopted to apply it within a nursery interior environment and make design recommendations that consider both pedagogy and spatial design.

4. Data Analysis:

4.1. Questionnaire

4.1.1. Sample size calculation

In this study, the sample size was identified based on the population available in the five participating nurseries. Each of these nurseries had around seven teachers and fifty enrolled children as per the records that the five nurseries maintained. In total, there were 203 respondents for the study, compromising 35 teachers and 168 mothers of toddlers aged one to four years. This number represents both professional and parental perspectives. The larger number of mothers reflects the demographic composition of the nursery communities, where

the number of parents is higher than the staff members. The sample size was appropriate, as it was sufficient to gain valuable insights within the scope of the study.

The finite population is 200 parents of toddlers, N=200

To determine the sample size is detailed as below:

- Confidence level: Z=95%
- Margin of error: e=5%
- The estimated proportion p = 0.5, worst case, gives the largest sample size

Using the standard formula for proportions, Cochran's method + finite population correction [48]:

First, a calculation of the original sample size, based on an infinite population, was done referring to formula {1}:

$$n_0 = \frac{Z^2 p(1-p)}{e^2} \qquad \{1\}$$

Where:

- n_0= required sample size
- Z= Z-score for desired confidence level (1.96 for 95%)
- p= estimated proportion (commonly 0.5 for maximum variability)
- e= margin of error

$$n_0 = \frac{1.96^2 * 0.5(1-0.5)}{0.05^2}$$

- Then, n_0=384.16

Second, the calculation of the Finite population correction is accrued based on formula {2}

$$n = \frac{n_0}{1 + \left(\frac{n_0 - 1}{N}\right)} \qquad \{2\}$$

Then,

$$n = \frac{384}{1 + \left(\frac{384 - 1}{200}\right)}$$

So, n=131.7

Required sample size ≈ 132 respondents

This would mean that even when dealing with an exact population of 200, collecting responses from about 132 toddlers' parents will create statistically valid results at 95% confidence with a margin of error of 5%.

4.1.2. Survey Results Validation

To make sure that the information gathered using the questionnaire is valid, a variety of verification methods were used. Among these methods include screening those who have answered all their responses with option one, estimating the time taken to fill in the

questionnaires, and screening for any contradictory responses. A comprehensive explanation of this information is detailed in the table below.

Table (4): Data Validation

Validation methods	Number of excluded responses	Number of valid responses
Straight-lining Detection	3 out of 203 interviewees (1%) selected only the 1st option as response to all the questions.	200 valid responses, representing 99% of total responses.
Speeding Detection (Average time spent is 5 minutes)	8 out of 203 interviewees (4%) spent less than 5 minutes responding to all the questionnaires.	195 responses, representing 96% of total responses.
Cross-item Consistency Validation	-1 interviewee answered YES to Q2 while answering NO to Q5, which means that the respondent does believe in promoting toddlers' independence but denied access to shelves, which contradicts the principle of autonomy -2 interviewees responded to Q6 by prioritizing safety only while in Q2 they strongly agree that independence is important, which means that respondents are ignoring accessibility or autonomy in design while emphasizing independence. →3 out of 203 interviewees (1%) are having contradictory responses.	200 valid responses, representing 99% of total responses.
Totals	Total number of excluded responses is 14, representing 6% of total responses.	Total number of valid responses is 189 out of 203, representing 94% of total responses.

4.1.3. Bias study

The standardized outcome rates following AAPOR (RR1) were calculated reporting valid completes over the eligible frame (teachers, parents) [49]. Then a finite-population correction was applied to all standard errors and confidence intervals given that valid samples constituted 80.4% of the finite population (N=235) and 77.0% of parents (N=200). Non-response risk was assessed using subgroup comparisons and, where possible, auxiliary data; bias is proportional to both the nonresponse rate and differences between respondents and nonrespondents. In order to reduce composition and coverage bias, and weights were adjusted so the combined teacher–parent estimates reflect population shares; cluster effects by nursery were evaluated via intra-class correlation and corresponding design effects.

Table (5): Bias calculation

Group	Eligible (N)	Valid responses (n)	Response rate	95% MOE (worst-case p=0.5, with FPC)
Teachers	35	35	100%	~0 pp (census; sampling error ≈ 0)
Parents	200	154	77.0%	±3.8 pp
Overall	235	189	80.4%	±3.16 pp

To ensure the strength of results from the questionnaire, the actual sample size was checked against the minimum threshold estimated based on conventional sampling theory. Therefore, the 189 valid responses achieved in the study substantially exceeded the minimum requirement of 132 determined for a population of 235 at a 95% confidence level and 5% margin of error. Excess improves the precision of estimates and reduces potential issues with sampling error, hence strengthens the reliability of the findings. In addition, the high response rate across participants in general (80.4%) and among all the teachers (100%) immensely lowers the risk of nonresponse bias. The reasons listed above give solid grounds for the acceptance of the dataset for further inferential analysis.

4.1.4. Questionnaire Results and analysis

The questionnaire received 189 valid responses out of a total population of 235; it was inclusive of full participation from all 35 teachers and 154 parents, hence assurance of adequate representation across the five nurseries. The following analysis presented a descriptive statistic to analyze stakeholders' opinions, perceptions, and practices particularly related to classroom design, and generally concerning early childhood education. Findings are presented in alignment with the study objectives, supported by tables and figures for clarity. Please refer to appendices (A).

The attributes of the questionnaire were determined through Montessori philosophy. This is because Montessori environments tend to be child centered. The attributes were clarified through the process of the survey [50]. The study targeted the two most important groups (teachers and mothers). This is because the two categories interact most frequently with the toddlers. A closed-ended questionnaire was used because the study required quantitative research. Percentages were used to provide insights into the level of consensus among the groups. This resulted in a table that equated the perceptions of the respondents to the Montessori framework. While parents and teachers are the children's main observers, they provide valuable insights into the correlation between the classroom settings and the children's developmental skills. The evaluation of these aspects helps the designer to create interior classrooms reflecting Montessori principles, which consider sensory exploration, independence, safety, and guided freedom. Linking each of these aspects to Montessori theory facilitates the assessment of the classroom's atmosphere, while insights from parents and teachers present useful support to improve pedagogical practices and classroom design.

4.1.5. Questionnaire statistical analysis

The statistical method applied to interpret the results of the questionnaire is the ANOVA statistical analysis method. For ANOVA across stakeholders, the focus was on the binary endorsement items where both Teachers and Parents reported "Yes"/agreement counts.

Table (6): Questionnaire statistical analysis

Question (mapped to Montessori feature)	**Total Number and percentage of teachers responding (Yes)**	**Total Number and percentage of parents responding (Yes)**	**The significance of questionnaire aspects**
Q1 **Comfort** (Active movement → Comfort in classrooms)	**Number:** 25 out of 35 **Percentage:** 71%	**Number:** 145 out of 154 **Percentage:** 94%	Comfort plays an essential role in the motor development and security of toddlers. The factor is a major preference for educators (71%) and mothers (94%), highlighting a strong consensus.
Q2 **Independence** (Self-directed learning/self-discipline)	**Number:** 30 out of 35 **Percentage:**86%	**Number:** 136 out of 154 **Percentage:**88%	Giving children independence encourages self-confidence and autonomy, primordial within the Montessori approach. A strong consensus between teachers (86%) and mothers (88%) validates the relevance of self-confidence.
Q3 **Openness** (Classroom Activities→ Sensory insight	**Number:** 25 out of 35 **Percentage:**71%	**Number:** 144 out of 154 **Percentage:**93%	Open spaces and activities with high sensory content are essential for the purposes of exploration as well as creativity. Both groups feel the need for the same (71% teachers and 93% mothers).
Q4 **Shelf access** (Freedom & responsibility → Accessibility)	**Number:** 25 out of 35 **Percentage:** 71%	**Number:** 66 out of 154 **Percentage:**57%	Accessible shelves encourage responsibility and autonomy. Teachers (71%) place strong stress on this skill, but mothers (57%) share reservations about safety.
Q5 **Safety** (Observation → Classroom safety)	**Number:** 33 out of 35 **Percentage:** 94%	**Number:** 132 out of 154 **Percentage:** 86%	Safety underlies trust and exploration. Almost all teachers (94%) and mothers (86%) rank it high, so it becomes non-negotiable.
Q6 **Spatial Design Components** (Environment → Interior design)	**Safe furniture:** **Number:** 35 out of 35 **Percentage:**100% **Interactive floors:** **Number:** 20 out of 35 **Percentage:**57% **Greenery:** **Number:** 15 out of 35 **Percentage:**42% **Natural Light:**	**Safe furniture:** **Number:** 142 out of 154 **Percentage:**92% **Greenery:** **Number:** 121 out of 154 **Percentage:**79% **Natural Light:** **Number:** 120 out of 154 **Percentage:**78% **Interactive floors:** **Number:** 119 out of 154 **Percentage:**77% **Shelving:**	Factors such as safe furniture, natural light, greenery, interactive floors, and shelving all have direct effects on well-being and engagement levels. In this regard, both teachers and mothers rated "safe furniture" as the most vital element (100% and 92%, respectively).

Question (mapped to Montessori feature)	Total Number and percentage of teachers responding (Yes)	Total Number and percentage of parents responding (Yes)	The significance of questionnaire aspects
	Number: 15 out of 35 **Percentage:**42% **Shelving:** **Number:** 15 out of 35 **Percentage:**42%	**Number:** 99 out of 154 **Percentage:**64%	

a) Descriptive Summary

To verify the proposed study, an alignment of the items in both groups was completed:

- *Questions 1–5 (goals of Montessori):* Comfort, Independence, Openness
- *Q6 (Components of Spatial Design):* Safe furniture, Interactive floors (colorful rugs, flooring), Indoor greenery, Natural light (large windows), Shelving.

For each feature, the proportion of "Yes" answers has been used:

- Teachers: counts out of 35
- Parents: counts out of 154

Accounting for question-to-question variation, and using a variance stabilizing transform, there is no overall systematic difference between Teachers and Parents in endorsement rates across the Interior Design aspects.

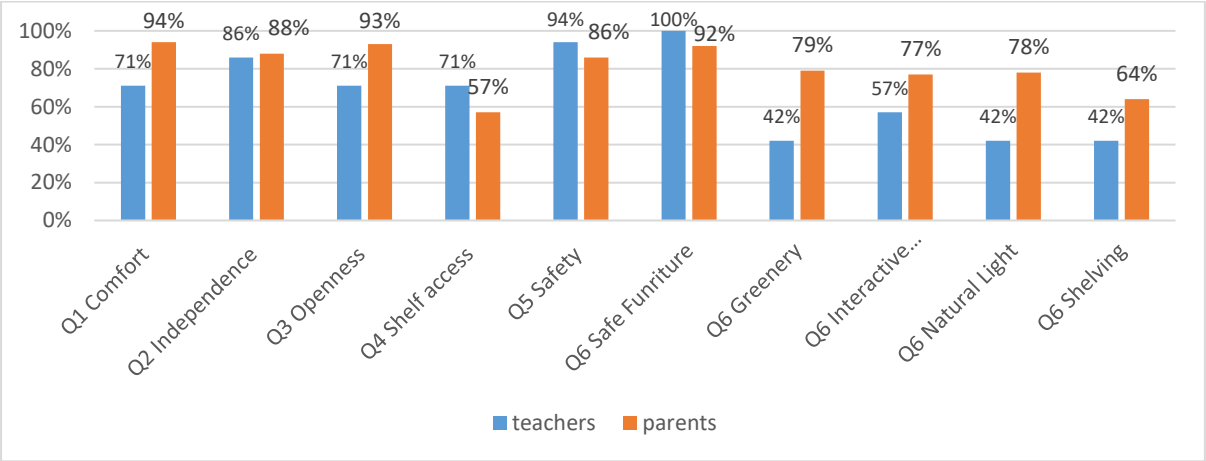


Figure (1): Teachers vs Parents evaluation percentage for significant of design aspects

While the overall effect is negligible, individual questions show significant gaps as explained in figure (1) and table (7):

Table (7): Endorsement percentages by stakeholders

Interior Design Feature	Parents − Teachers (percentage points)
Comfort	**+22.8 %** (Parents higher)
Independence	**+2.60 %** (Parents higher)

Openness	**+22.1 %** (Parents higher)
Shelf access	**−28.6 %** (Teachers higher)
Safety	**−8.6%** (Parents higher)
Safe Furniture	**−7.8 %** (Teachers higher)
Interactive Flooring	**+20.2%** (Parents higher)
Natural Light	**+35%** (Parents higher)
Indoor Greenery	**+35.7%** (Parents higher)
Shelving	**+21.4%** (Parents higher)

b) Patterns:

High consensus on both safety and safe furniture among both groups (≥85%). It indicates significant endorsement of natural light and interior plants (+35% on average and +20% on floors with interaction capabilities). The importance of gaining access to shelves, safety, and safe furniture increases significantly for teachers (+29%).

c) *Results of ANOVA-style on arcsine-transformed proportions* [51]

Arcsine square-root transformation was employed on arcsine square-root to change to ratios and conducted a Two-way ANOVA Without Replication with factors Group: Teachers vs Parents; Feature: 10 interior design elements) using formula {3} [52]:

$$r = \arcsin(\sqrt{\rho}) \quad \{3\}$$

This was to test:

- Main effect of Group (Are the overall proportions different between teachers and parents?)
- Main effect of Feature (Do endorsement rates differ across features?)

The advantage of the arcsine transform is that Variances are proportionally bounded in [0,1]. The arcsine square-root transformation is a common method used to stabilize the variance for ANOVA proportion data.

Group (Teachers vs Parents):

- $F = 14.49$, $df = (1,9)$, $p \approx 0.004$, Partial $\eta^2 = 0.617$(large effect)

Feature (10 interior design elements):

- $F = 9.77$, $df = (9,9)$, $\mathbf{p \approx 0.002}$, Partial $\eta^2 = 0.907$(very large effect)

There is a statistically significant difference between teachers and parents overall (main effect of Group). Parents, on average, express stronger support for all of these design features, especially light/greenery/flooring.

There are significant differences among the factors (main effect of Feature). Not all individual factors of class-room design are viewed similarly; “Safe furniture/safety” is highest while “Indoor greenery/natural light/shelving/interactive floors” differ according to the stakeholder.

d) ANOVA test Interpretation

The data shows a legitimate convergence on the primacy of safety in the design of the classroom environment, where safety and safety-compliant furniture were the amelioration at the top of the list as rated by teachers as well as by parents, an implication that was reaffirmed by the ANOVA test, where the analysis revealed substantial significance among design elements ($p \approx 0.002$) and very high means on the design elements concerning safety. On the other hand, the significance of the group effect in the analysis ($p \approx 0.004$) means that parents rate environment, particularly natural light and indoor plants, as of far greater import, placing a priority on design that includes substantial daylighting through large windows with flexible sizes, as well as biophilic design elements such as low-maintenance, non-allergenic indoor plants.

Table (8): Observation Checklist

Category	Behavior Indicators	Observation	Notes
Comfort & Safety	Child moves around without bumping into furniture; avoids sharp edges; calm appearance	All the 50 Children (100%) are moving freely without collision during playtime which makes all toddlers feel calm and smiling	Classroom layout supports safe movement, no sharp corners observed
Autonomy & Independence	Child independently accesses bookshelves; and chooses all playing materials alone	During playtime, 46 out of 50 toddlers (92%) selected toys and books without the teachers’ help	Higher independence noted in older children aged from 3 to 4 years old
Engagement in Creative Play	Child is involved in artistic and group activities; uses creative corners well	During morning circle time, around 45 out of 50 children (90%) were positively engaging in singing and dancing activities During craft activity, 48 out of 50 toddlers (96%) participated in modeling and coloring activities	Very few toddlers preferred quiet play zones, noticeably younger children aged from 1 to 2 years old
Use of Space	Child chooses open floor spaces to move around; utilizes allocated areas effectively	47 out of 50 children (94%) uses Open floor area for movement during free play time	Creative corners were used more during structured activities
Interaction with Furniture	Child comfortably uses child-sized furniture; Child can sit and work without help	During lunch time 49 out of 50 children (98%) seat independently in child-sized chairs to eat their snacks	younger children aged from 1 to 2 years old need assistance due to their young age
Lighting & Mood	Child spends time around the naturally lighted zones; exhibit positive affect	During story time, 45 out of 50 children (90%) preferred to sit near the window.	Natural light areas are often linked with calm and focus areas

Category	Behavior Indicators	Observation	Notes
Interactive Flooring	Child engages more actively with patterned/color coded rugs; uses rug zones for playing or group activity.	47 out of 50 children (94%) tended towards colorful/Interactive Rugs in free & group sessions	Colored rugs and carpets can be a useful method of encouraging participation and can contribute to the definition of activity areas.
Indoor Plantation	Child demonstrates curiosity about indoor plants; plays normally around greened areas	44 of 50 toddlers (88 percent) played around plant-integrated corners, mostly in quiet/sensory exploration experiences	Adding some greenery aspects into the indoors, such as indoor plants, had an impact on creating a calming interior environment.

There was substantially greater support among parents for interactive and colorful flooring, an implication that stress on chromatically zoned as well as very durable, non-slip flooring surface materials could effectively limit student overstimulation in the class. Conversely, teachers were substantially more in favor of accessible shelving, a reflection of the Montessori approach that encourages autonomy, implemented by freedom and responsibility, an implication the class design must seek a balance between perimeter shelving, path-of-circulation clarity, and a heightened level of visibility.

4.2. Observation Study

4.2.1. Observation study Data Collection

Observational data from five nurseries were compiled to establish generalizable patterns of aligned behavioral responses to the Montessori setting as explained in table (8).

A summary of the observations collected from five nursery settings, using the eight categories of interest, can be effectively presented in the visual format of the detailed chart given below. These include Safety & Comfort, Autonomy & Independence, Use of Space, Interaction with Furniture, Lighting & Mood, Engagement in Creative Play, Colorful & Interactive flooring, and indoor plantation. Accordingly, the chart synthesizes frequency counts and percentage distributions for each category, which give clarity on how well the design supported desired behaviors in a classroom setting. This graph thus gives an overview of what is found in this research study to highlight areas of excellence and give recommendations on areas for improvement concerning early childhood learning environments.

4.2.2. Observation study Analysis

As shown in figure (2-a) and figure (2-b), Fifty toddlers showed a remarkable level of compliance with classroom design indicators through careful observation. All children (100%) showed safe and comfortable mobility, avoidance, calmness, autonomy, and independence as

all children accessed shelves and materials without help. Autonomy and independence showed a level of compliance among 46 children (92%), who accessed shelves and materials without adult help. Space use showed effectiveness among 47 children (94%), who showed a preference for open floor areas and proper use of designated areas. Interactions between children and furniture showed a nearly universal level of compliance among 49 children (98%), who showed proper sitting and eating on children's furniture. Indicators for light and mood showed a level of compliance among 45 children (90%), who spent time around areas that received natural light and showed positive effect. Added to that, 47 children (94%) preferred spending their free play time on Colorful rugs and 44 other children (88%) decided to give extra attention to the indoor plantation. Creative play activities also showed a remarkable level of compliance as 45 children (90%) showed active participation during morning circle, 45 children (90%) during artistic activities, 48 toddlers (96%) during craft activities, 47 children (94%) during free play time, 49 children (98%) during lunch time, and 45 children (90%) during story time.

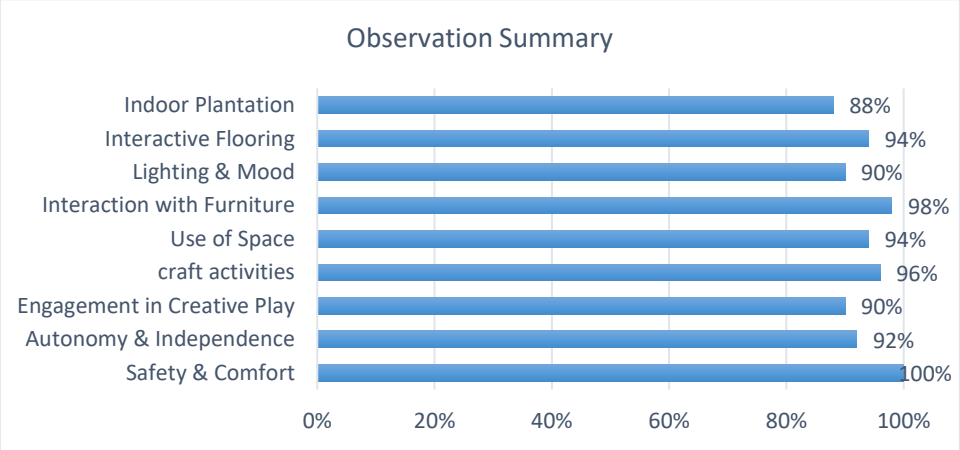


Figure (2-a): Summary of Classroom observation dashboard

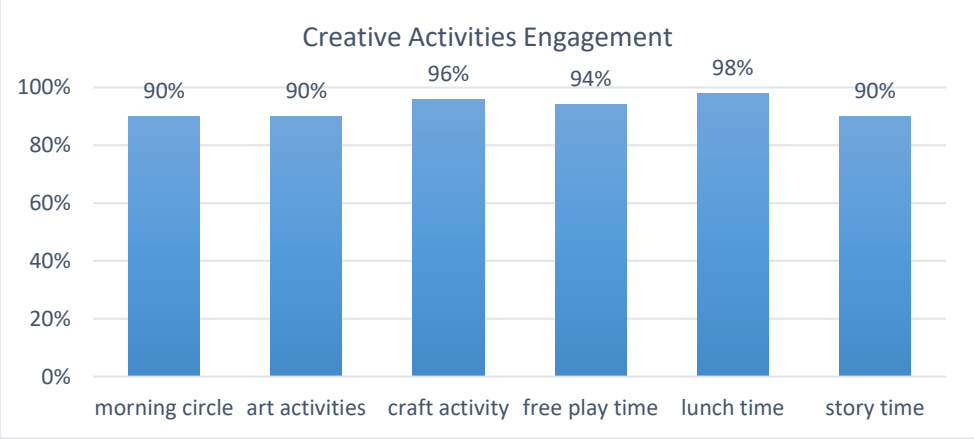


Figure (2-b): Creative activities in Classroom observation dashboard

4.2.3. Observation study results validation

The validation of the observation study was conducted using T-test statistical validation against an 80% benchmark, Compliance using a one-sample T-test approximation for proportions (n = 50) and referring to the below formula {5} [53]:

$$t = \frac{\hat{p} - 0.80}{\sqrt{\frac{\hat{p}(1-\hat{p})}{\sqrt{n}}}}, n = 50 \qquad \{5\}$$

(H_0: ρ=0.80, H1: ρ ≠0.80, n=50) (H_0: ρ =0.80, H_1≠0.80, n=50)

Proportions are treated as the mean of a Bernoulli variable; ρ values use a normal approximation. 95% CIs are Wilson intervals. The results of T-test statistics are detailed below:

Table (9): T-test Statistics

Category	Observed Proportion	t-statistic	p-value (two-sided)	95% Wilson CI
Comfort & Safety	1.00	∞	< 1e-12	(0.929, 1.000)
Autonomy & Independence	92%	3.128	0.00176	(0.812, 0.968)
Engagement (Morning circle)	0.90	2.357	0.01842	(0.786, 0.957)
Engagement (Craft activity)	0.96	5.774	0.00000	(0.865, 0.989)
Engagement (Artistic activity)	90%	2.357	0.01842	(0.786, 0.957)
Use of Space	0.94	4.168	0.00003	(0.838, 0.979)
Interaction with Furniture	0.98	9.091	0.00000	(0.895, 0.996)
Lighting & Mood	90%	2.357	0.01842	(0.786, 0.957)
Interactive Flooring	94%	4.168	0.00012	(0.838, 0.979)
Indoor Plantation	88%	1.741	0.08800	(0.762, 0.944)

The one-sample t-test reveals that all of the results are well above the 80% level of compliance, including the following: Confidence & Safety of 100%, Level of Autonomy & Independence of 92%, Engagement in creative activities of 90 to 96%, Correspondence to Use of Space of 94%, Interaction with Furniture of 98%, and Level of Lighting & Mood of 90%, Interactive flooring 94% and Indoor plantation 88%. The confidence intervals of all of the results are well above 80%.

4.3. Benchmarking Study:

4.3.1. Case studies Observation

a) Local Case Study: Ajyal Montessori, Kingdom of Bahrain

The classroom at Ajyal Montessori shown in figure (3) revealed a typical example of classroom design, where Montessori elements are showcased through its simple and well-arranged space. Two large windows stretch almost across the width of one wall, allowing maximum natural lighting and ventilation that create an open, peaceful, and airy atmosphere in the classroom. There is effective zoning, which is organized in child-friendly activity spaces that offer maximum autonomy and smooth workflow movement. Child-sized, low-standing wooden furniture and open shelves also promote easy accessibility and utilization, which helps create independence and responsibility in the child. Unobstructed circulation paths enable child movement between zones, with no obstacles. The use of parquet flooring also ensures special zones with sensory experiences, which helps in the designation of child activity zones. Use of child-friendly positioned indoor plants also enriches the experience by bringing nature near to the child.

Source: [54]

Figure (3): Classroom interior at Ajyal Montessori nursery

b) Local Case Study: The children house, Budaiya, Kingdom of Bahrain

The classroom in The Children House shown in figure (4) consists of various spatial elements that are linked to the Montessori philosophy. The major method that is involved in this class is the integration of bright and interactive marine colors that are incorporated through the painting of the walls as well as some of the furniture. The major significance of this concept is that it incorporates an interactive and visible feature that gives the toddlers the impression that they are an integral part of the class. The zoning of the indoors is clearly defined and includes child-size furniture and shelves that are placed in every activity zone to enable easy accessibility by the toddlers. The pathway through the zones is also open and free to enable easy access from one activity to the next that is essential in Montessori classes. The concept of natural light is effectively incorporated as sufficient light is employed to make this place even more open and natural. This is further supported by the carefully placed low-lying furniture that assists with visibility and proper sightlines that ensure the openness of the place.

Source: [55]

Figure (4): Classroom interior at the children house nursery

c) Local Case Study: Little wonders preschool, Saar, Kingdom of Bahrain

The classroom in the Little Wonders Preschool shown in figure (5) includes various Montessori-inspired interior design features. For instance, flooring contains interactive aspects allowing toddlers to discover and explore their motor skills. The insertion of child-scale furniture with safe materials with smooth corners boosts independence and safety. Also, the reflected ceiling effectively blends with the interesting atmosphere, creating a harmonious interior setting that stimulates toddlers. The classroom has pre-defined zones, allocated for learning, playing, or exploration purposes, so that toddlers can independently experience this learning space. Further, lighting helps children boost their sensory skills while also being able to move fluidly around the room. Although the classroom has limited greenery, child-friendly plants would help boost children's responsibility.

Source: [56]

Figure (5): Classroom interior at Little Wonders pre school

d) Regional Case Study: Redwood Montessori nursery, Abu Dhabi, UAE

The classroom in *Redwood Montessori Nursery* shown in figure (6) is designed to incorporate a sense of openness, because of its large area, promoting interaction among toddlers during playtime. Also, it is well-zoned, allowing fluid circulation flow. The lighting is appropriate, creating good indoor ambiance, that facilitates interaction among the toddlers. In addition, the accessibility to the playing materials offers freedom for children to accomplish their respective tasks independently. Particularly, it can be observed that shelving is positioned at lower height for toddlers to access. Additionally, wide circulation paths are guaranteed, thus improving easy flow from one learning area to another. Therefore, there are adequate features in the interior for facilitating interaction among toddlers for improving their sensory development, specifically because it has few plantations, thus allowing toddlers to connect with nature.

Source: [57]

Figure (6): Classroom interior at Redwood Montessori nursery

e) Regional Case Study: Smart kids Montessori, Al Arid, KSA

The Smart Kids Montessori environment setting illustrated in figure (7) and figure (8) showed a spatial setting that is nearly ideal with regards to the Montessori interior design approach, promoting functionality, accessibility, and stimulation. In the *Smart Kids Montessori* classroom, curved shelving blocks promote the reduction of space boundaries, allowing for smooth toddler movement and transitions between activities. For instance, toddler activity involves the dedication of a specific table, shelf, and signs to each station, promoting independence of toddlers. Wooden floors, in one way, are promoted by interactive carpet placed in the middle of the space, allowing the creation of functional toddler spaces with enhanced space stimuli. Natural Light also promotes the creation of an environment that appears open and lit. For instance, child furniture promotes complete toddler space accessibility, with the toddler effortlessly taking play materials. On the other hand, circulation pathways are wide and clear, promoting toddlers' movement within space. Though it appears to be a very functional environment for toddlers, addition of indoor plants would help promote a strong sense of greenery.

Source: [58]

Figure (7): Classroom interior at Smart kids Montessori nursery

Source: [59]

Figure (8): Classroom interior at Smart kids Montessori Nursery

f) Regional Case Study: Little Montessori nursery, Doha, Qatar

As observed from figure (9), the *Little Montessori Nursery* classroom incorporates very good zoning, because of the colorful grid rug, which divides the space into the predominant activity area. In terms of lighting, the effect on the entire space is lighted due to the recessed ceiling fixtures. This makes the space very bright. There are also lower furniture, shelves, and very colorful hues. This gives the toddlers the ability to sort the playing items independently. Indeed, the space is very open as the floor is seamlessly covered by a colorful and decorative rug. The toddlers can walk freely from the playing and learning corners. The space lacks greenery. Adding plantations would make the space very natural.

Source: [60]

Figure (9): Classroom interior at Little Montessori nursery

g) International Case Study: AMONCO, United States of America

The class in *the AMANCO Nursery* shown in figure (10) reflects Montessori's approach in the following ways:

Source: [61]

Figure (10): Classroom interior at

The windows allow the penetration of good amount of natural lighting, making this classroom appear well-ventilated and in touch with nature. Zoning is also done in this classroom, placing small wooden tables and shelves in their exact appropriate location. The classroom is also very open, considering that there is enough floor space that would allow kids to walk from one area to another freely. Indoor plants provide a sense of calm and connection with nature, while also promoting indoor greenery.

The flooring of this classroom is seamless centered by a rug promoting the interactivity of toddlers. Also, the openness of the classroom design and wide floor spaces provide children with ample opportunities for self-directed physical activity, in accordance with Montessori principles of child-centered educational approach.

h) *International Case Study: International school in Brussels, France*

The classroom at *the International School, Brussels*, appearing in figure (11), also embodies very essential Montessori classroom design elements, including extensive use of natural and artificial lighting. There are numerous high windows permitting sufficient natural illumination of each activity area, while fixed LED lighting ensures equal brightness across the space. The classroom is also well-zoned, with small wooden tables and shelves suitable for the children, set up for children to work alone or choose activities. This large classroom creates a sense of openness, with open pathways to ensure smooth circulation around the classroom. Also, the flooring is seamless, and clutter-free for kids to circulate easily. Greenery brings in a touch of nature.

Source: [62]

Figure (11): Classroom interior at international school in Brussels

i) International Case Study: SPIENTIA Montessori, United Kingdom

Source: [63]

Figure (12): Classroom interior at SPIENTIA Montessori nursery

Figure (12) shows that there is notable openness in the classroom at *SPIENTIA Montessori Nursery*, boosting free movement and floor-level activities. Many large windows are placed at multiple positions on the classroom perimeter to ensure sufficient natural lighting. This makes the indoor environment more open and brighter. The zoning in the classroom is clearly marked by rugs and wood desks. The desks and shelves are child-friendly and are situated at different locations to maintain child independence. An open space serves as an interactive floor, and circulation pathways are maintained clearly to help free flow of movement. A considerable number of plants are grown in this class, introducing greenery. Hence, this classroom environment is well-designed, incorporating lightness, openness, accessibility of materials, and greenery.

4.3.2. Case Studies Interpretation

The following attributes characterize the interior design of nine classrooms across various nurseries, obtained through spatial analysis. These have been synthesized in line with the principles of Montessori-friendly environments and are hereby detailed below.

At Ajyal Montessori, various design elements play a crucial part in supporting children's development. Such as *the zoning,* which groups child-friendly activity areas together to facilitate autonomy and a smooth learning flow. This helps the toddlers to recognize where the activity areas are, which in turn allows the children to make independent choices. Another element is the use of *lighting*, which is provided by the large windows that allow enough natural light and ventilation. This provides a peaceful space that improves the toddlers' mood, awareness, and comfort. Furthermore, *the furniture and shelving* are designed at a child's scale, consisting of low-to-the-floor wooden furniture and open shelving that permits the children to access the materials independently. This fosters independence, responsibility, and self-directed learning. *The interior environment* is uncomplicated and well-organized, which gives a calm and serene ambiance. This prevents over-stimulation, allows the children to be calm while exploring the surroundings, and increases the clarity of the interior. *The interactive floorings*, such as parquet, serves as clear marking of activity areas, which increases sensory experience, hence improving touch learning, helping the toddlers comprehend space, and improving sensory learning. *Circulation and movement* are ensured through the availability of unobstructed pathways between the zones, which increases the freedom of movement in line

with the Montessori philosophy. Finally, the placement of *greenery*, such as indoor plants at appropriate heights, increases the toddlers' connection to nature, calms the children, and increases the sensory learning of the toddlers.

At The Children House, there are various Montessori design elements, which play a critical role in determining the experience of toddlers. *The zoning* of the classroom is done in a way that each activity is assigned a specific zone with child-scale furniture and shelving, which creates a sense of belonging and relevance. The effective use of *lighting* creates an open space through natural brightness, which creates a calm focus, visual comfort, and a bright learning environment. *The furniture and shelving* are low-scaled, child-proportioned, and open, with active, marine-themed colors, which facilitate easy retrieval and return of materials, promoting visibility, and a sense of belonging. *The interior environment* promotes a sense of openness through the use of lighting and low furniture, which creates easy view paths, reduces clutter, and facilitates easy surveillance. *The interactive flooring*, made of wooden parquet, creates a sense of safety for toddlers, while *circulation and movement* design ensures a clear and open path, allowing for safe transitions, easy movement, and a sense of freedom, as advocated by Montessori.

In the case of Little Wonders Preschool, there are multiple thoughtful considerations in terms of Montessori design, such as *zoning,* which involves dividing the space into areas that are conceptually designated for play, learning, and exploration. Zoning boosts toddlers' independence and self-navigating play. Optimum *lighting* helps to achieve a sense of spaciousness and openness. The *furniture and shelving* are designed for young children, being constructed from non-hazardous materials and having smooth, rounded edges. The *interior environment*, with a reflected ceiling, adds interactive, engaging, and harmonious atmosphere, which is essential for promoting active participation. The *interactive flooring* offers a sense of exploration, which is essential for motor and cognitive development. The *circulation and movement* design are thoughtful, as they allow for easy zoning, enabling toddlers to move in and out of, and through, areas. Lastly, there is a sense of responsibility and connection to *nature*, as there are a few plants in place.

At Redwood Montessori Nursery, the environment is well-designed to support the development of toddlers based on several Montessori design factors. *Zoning* helps create functional areas for the toddlers, making transitions between activities more fluid. Effective *lighting*, provided by the ceiling, creates an environment that encourages the toddlers to

socialize, concentrate, and maintain a peaceful playing environment. The *furniture and shelving* are placed at the toddlers' height, encouraging independent access, thereby promoting independent learning, autonomy, and confidence without the interaction of adults. The *environment* itself is spacious, encouraging the inclusion of several sensory activities, thus preventing overcrowding, socialization among the toddlers, and sensory development. Although *interactive flooring* is not included, the classroom has effective and fluid *circulation* paths, with the inclusion of wider movement areas and the use of zoning patterns, thus preventing congestion and encouraging the children to be involved in active collaborative play. Finally, the inclusion of *greenery*, with several indoor plants, helps the toddlers develop and strengthen their relationship with the natural environment.

In Smart Kids Montessori, the *Zoning* is achieved by creating activity stations, each child has a particular table, low shelf, and signs on the wall. This helps toddlers to independently identify, select, and move to activities easily. The *lighting* helps in creating an open environment, which is warm, that fosters a comfortable environment and encourages prolonged activity. The *furniture and shelves* are designed to be child-sized, low, and curved, to ensure complete accessibility to all materials, promoting independent learning and smooth transitions. The *interior environment* is designed to be spatially linked to the Montessori philosophy, promoting functionality, accessibility, and stimulation. The *interactive flooring* includes wooden floors and interactive carpets, to define areas and encourage tactile learning. Lastly, the *circulation and movement* involve wide open paths and curved shelves, to allow safe transitions, prevent congestion, and encourage gross motor exploration, promoting freedom of movement for toddlers.

At Little Montessori Nursery, *the zoning* is considered through a colorful grid rug, which helps to divide the room into major activity zones. Which boosts Toddlers' self-independence. *The lighting* helps to provide a bright atmosphere, which promotes visibility, attention, and participation. The *furniture and shelves*, which are low and painted in bright colors, encourage categorizing and independent selection of playing materials. The *interior environment,* with a wider floor area, helps to prevent congestion, encourage interaction through play, enhance exploration and improve comfort. *Interactive flooring*, such as carpets, encourage tactile learning, which is part of Montessori learning. It Encourages tactile learning, thus aiding experiential Montessori-learning experiences. Lastly, while there is a limitation of *greenery*, it is proposed that the addition of toddler-friendly plants will enhance relaxation, promote biophilia, and enhance children's connection with nature.

At AMONCO, the *Zoning* is done through the use of wooden tables and lower shelves designed for children, which create zones that facilitate purposeful learning and enable toddlers to circulate independently. The classroom also has adequate *lighting* from the large windows, which not only provides natural lighting in the classroom but also connects the children with nature, promoting a relaxed atmosphere that improves moods, concentration, and stimulation. The *furniture and shelves*, which are designed for children, also promote autonomy by permitting toddlers to independently retrieve and return books. The *interior environment* is characterized by its openness, which is achieved through the large floor space and the inclusion of plants and natural sunlight, creating a spacious classroom that promotes autonomy, suppresses overstimulation, and promotes exploration. The *interactive floor* also promotes sensory perception through the seamless floor and the inclusion of a rug in the middle of the classroom, which increases sensory perception and learning by touch, offering a defined area for performing various activities. The *movement and circulation* in the classroom are also well designed through the large floor space, which boosts the physical development of the children and encourages autonomous activity. Finally, the *greenery* provided by indoor plants creates serenity, improves environmental quality, and reinforces the toddlers' relationship with nature.

At the International School in Brussels, *zoning* is achieved through the use of small wooden tables and child-sized shelves to promote independence, autonomy, and purposeful engagement in typical Montessori activities. The *lighting* is provided through large windows, LED bulbs, which provide even distribution of light, and to promote concentration, visual comfort and productivity. The *furniture and shelves* help the creation of spacious classrooms, allowing the child to autonomously choose and return materials, promoting responsibility and self-directed learning. The *interior environment,* with its open space, minimizes distraction, creates calmness, and lets toddlers concentrate on activities. *Interactive floor* is minimal and clutter-free, providing a space for toddlers to safely explore. *Movement and circulation* are promoted by wide paths to safely move between learning areas. Lastly, the addition of *greenery* through plants brings a natural touch, which enhances the feelings of calmness, thereby increasing toddlers' connection with nature.

At SPIENTIA Montessori, the *Zoning* is achieved through the use of a rug and wooden desks, which define areas of activity and helps toddlers to recognize areas of activity, to make their own decisions. Adequate *lighting* is provided through large windows, strategically positioned to create a well-lit environment, which is effective in mood enhancement, focus, and visual comfort. The *furniture and shelving,* which are child-friendly, are placed to

encourage a sense of responsibility and independent decision-making. The open and accessible *interior environment* helps to prevent overcrowding, distraction, and foster quiet cooperative activities. Toddlers are able to play in a large open area, which is covered with *colorful flooring*. The conception of *circulation and movement* is well thought, providing clear pathways for safe transitions. Additionally, there are various *plants*, which serve to enhance a toddler's sense of connection to nature, promoting calmness.

4.4. Methodology validation:

In order to make the findings of the research valid and reliable, the triangulation strategy was adopted. In this study, the findings from the questionnaire, observation, and benchmarking analysis were combined to overcome the limitations of each method and to gain a better insight into the application of Montessori design principles in the nursery setting.

The validation approach was developed based on convergent evidence from various sources that may help improve the reliability of the research. The questionnaire provided insights from adult perceptions, with teachers focusing on their pedagogical notions and mothers expressing autonomy, comfort, and safety considerations. The observation offered direct evidence of the toddlers' behavior, including their usage of materials, creative zones, and circulation patterns. On the other hand, the benchmarking analysis, physical attributes of nursery interior spaces were revealed and analyzed through application of Montessori guidelines.

The intersection of these three key pillars is represented by the triangulation matrix shown in figure (13), in which the questionnaire evaluates adults' perception, observation measures children's behavior, and the benchmarking assesses the environmental settings. This triangulation is represented in the triangulation table (10) and in figure (14) , and it verifies and validates the findings referring to the Montessori principles. This method adds robustness to the study by connecting toddlers' behavior, stakeholders' perceptions, and classrooms' design.

By applying methodological triangulation, the validity of the study is enhanced through a cross-verification of the data retrieved from various sources. This ensures that the research is both practical and theoretical, hence making the results of the research more reliable.

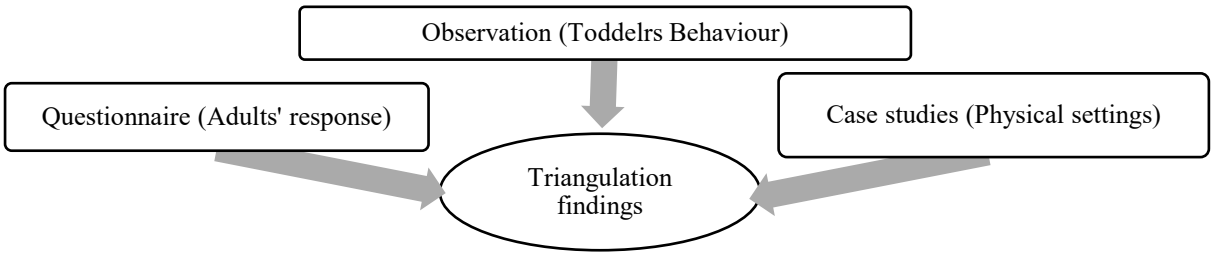


Figure (13): Triangulation Framework

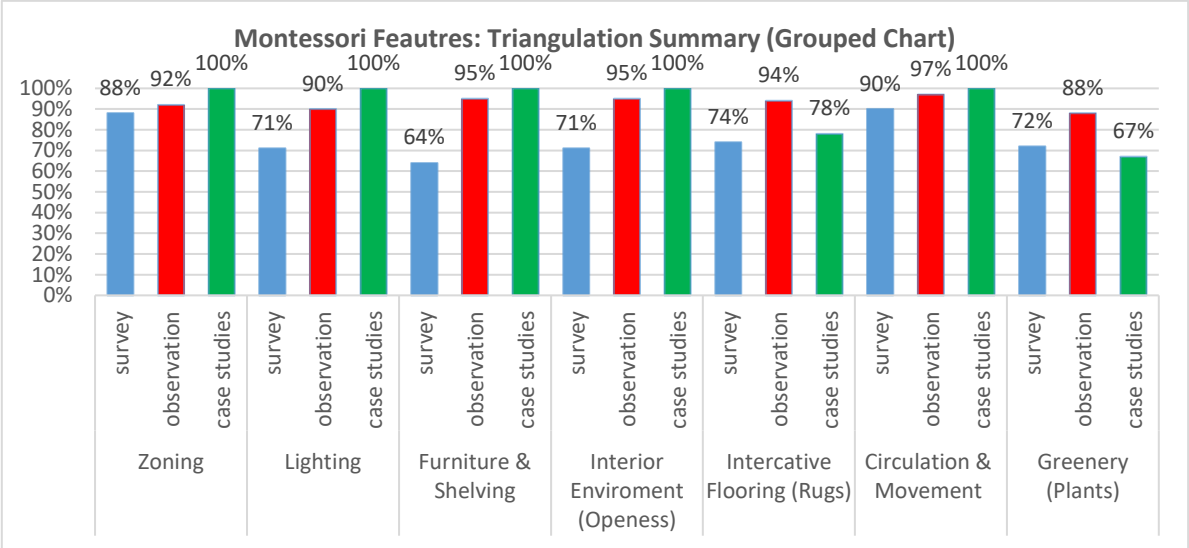


Figure (14): Triangulation Bar Chart

Table (10): Triangulation table

Montessori Feature	Questionnaire	Observation	Case Study Prevalence	Triangulation Verdict
Zoning	**Q2 Independence:** Teachers: 30/35 (86%) Parents: 136/ 154 (88%)	Children independently used activity areas: **Autonomy & Independence** 46/50 (92%)	**9/9** nurseries explicitly zone by activities	**Strong convergence:** consistent zoning enables autonomy.
Lighting	**Q6 Natural light:** Teachers: 15/35 (42%) Parents: 120/154 (78%)	**Lighting & Mood:** 45/50 (90%) preferred window areas during story time	**9/9** mention lighting (natural and/or well-distributed artificial)	**Strong convergence:** Observation Data and case studies are very strong; parents' agreements high.
Furniture & Shelving	**Q4 Shelf access:** Teachers: 25/35 (71%) Parents: 66/154 (57%)	**Interaction with Furniture:** 49/50 (98%) and 46/50 (92%) accessed materials	**9/9** have child-scaled furniture and low/open shelving	**Strong convergence:** observation and cases studies are extremely high; while positive parents' agreement is moderate but valid.

Montessori Feature	Questionnaire	Observation	Case Study Prevalence	Triangulation Verdict
Interior Environment (openness)	**Q3 Openness:** Teachers: 25/35 (71%) Parents: 144 out of 154 (93%)	**Use of Space:** 47/50 (94%) chose open floor during free play with high engagement 96%	**9/9** emphasize openness/serenity	**Strong convergence:** open and uncluttered interiors make physical movement and interaction easier for toddlers
Interactive Flooring (rugs)	**Q6 Interactive floors:** Teachers: 20/35 (57%) Parents: 119/154 (77%)	**Interactive rugs preferred:** 47/50 (94%)	**7/9** use interactive floors/rugs (2 not stated/absent)	**Moderate to Strong convergence:** observation and parent results are strong; although the incorporation of such flooring is high but not applied in all benchmarked case studies.
Circulation & Movement	**Q1 Comfort (active movement):** Teachers: 25/35 (71%) Parents: 145/154 (94%)	**Comfort & Safety:** 50/50 (100%) moved freely without collisions. Use of Space: 47/50 (94%)	**9/9** report unobstructed/wide paths	**Strong convergence:** very strong alignment across all the used methods.
Greenery (plants)	**Q6 Greenery:** Teachers: 15/35 (42%) Parents: 121/154 (79%)	**Indoor Plantation:** 44/50 (88%) used/played near green areas; calming effect noted	**6/9** include indoor plants	**Moderate convergence**: strong awareness from both parents' opinion and observation study, but the implementation rate varies from one case of study to another

The following interpretation shown in table (11) summarizes the level of convergence among the three methods for each Montessori design feature.

Table (11): Triangulation validation

Montessori Feature	Validation
Zoning	There is strong triangulation. All three methods proof that clearly zoned spaces foster autonomy, structured exploration, and smoother learning flow.
Lighting	Despite moderate teacher ratings, the observational and case studies data serve as strong validators for natural light. Convergence of these supports the claim that light quality contributes to mood regulation, visual comfort, and engagement, reinforcing the emphasis of Montessori on natural light.
Furniture & Shelving	There is strong convergence. The observational behavior and case-study proved the effects of child-scale furniture on their independence, which would strongly support Montessori's emphasis on the "child-friendly environment."

Interior Environment (openness)	The methods are in strong alignment. Open, simple environments support freedom of movement, and validate Montessori's principle of an orderly, aesthetically minimal environment.
Interactive Flooring (rugs)	Triangulation suggests a moderate to strong convergence. The observations clearly indicate that there is high engagement by the children, but given the uneven presence across nurseries, it is beneficial yet not universally in place.
Circulation & Movement	There is very strong triangulation. Safe, smooth movement supports autonomy and minimizes hazards, as well as being in line with Montessori's emphasis on physical freedom.
Greenery (plants)	Triangulation indicates moderate convergence. Clear benefits are shown through observational evidence, but the adoption across nurseries is variable, as are the responses to teacher questionnaires. Parents and children, though, show strong support.

The triangulation reveals a strong harmony of methodology between questionnaires, observation, and evidence from case studies, collectively supporting a set of essential Montessori environment elements, such as zoning, natural lighting, interior openness, child-scaled furniture and shelving, and unobstructed pathways, as crucial factors for promoting autonomy, comfort, sensory exploration, secure movement, and regulation for nursery-school children. The effect of interactive floors and indoor plants, while positive, also crucial for children's developmental processes, as evident from observation and parent evidence, yet irregular implementation across settings, results in moderate validation for these elements as well. The combined effect of the three above methods increases significantly the reliability of these results.

Through the alignment of these results with the objectives of the study, it is evident that the chosen interior design parameters, which include space zoning, circulation, lighting, accessibility to shelves and Child-scale furniture, floor finishes, and integration of natural elements, are not only measurable but are systematically linked with the Montessori principles. These aims are linked with interior design practice to bridge the gap between Montessori theory and interior design practice. It can also provide a solid basis for developing evidence-based design guidelines to assist interior designers and educators in developing authentic learning environments.

5. Discussion, Recommendation and Future Research:

5.1. Discussion

The outcomes retrieved from questionnaires, observational study, and benchmarking analysis, supported the connection between classroom spatial qualities and its effect in achieving the developmental needs of children. For instance, the questionnaire results revealed that both

parents and teachers agreed on the significance attributed to comfort and safety as aspects to be considered in design but also appreciated the value and contribution of various environmental factors, such as lighting, greenery, and creativity, in motivating and stimulating the child in the environment. Such considerations were also supported by results from observational study which revealed toddlers can circulate freely without any collision, accessing materials independently, and fully engaging in creative and group activities. Such behaviors imply that well-zoned, uncluttered, and well-lit spaces would likely facilitate children's autonomy, fluid movement, and well-being. Similarly, benchmarking nine case studies based on their compatibility with the Montessori approach reinforced the importance of various spatial design elements, such as natural light, open circulation, zoning, and child-scaled furniture, to cultivate independent learning, concentration, and emotional regulation behaviors in children. Collectively, stakeholder perspective, observed children's behavior, and best-practice evidence converge on a design hierarchy prioritizing safety, considering environmental aspects, to support toddlers' autonomy and wellbeing.

5.2. Practical implications

This research has shown that particular aspects of the interior classroom environment are directly linked to the activation of the principles of Montessori through the direct impact of sensory development, autonomy and safety in classroom settings. Through the data gathered using questionnaires, observations, and benchmarking, it was proven that zoning, circulation, lighting, child-scale furniture, and openness have primary role in boosting toddlers' developmental outcomes. The aspect of safety and comfort was also emphasized as a key area of focus through the feedback offered by the stakeholders, with the teachers highlighting the importance of open shelving and child-sized furniture, while the mothers highlighted the importance of environmental factors such as the availability of natural light and greenery. Observational results showed that toddlers freely and safely explored the space, which was clutter-free and lighted, had access to materials independently, and exhibited a high level of participation in creative activities.

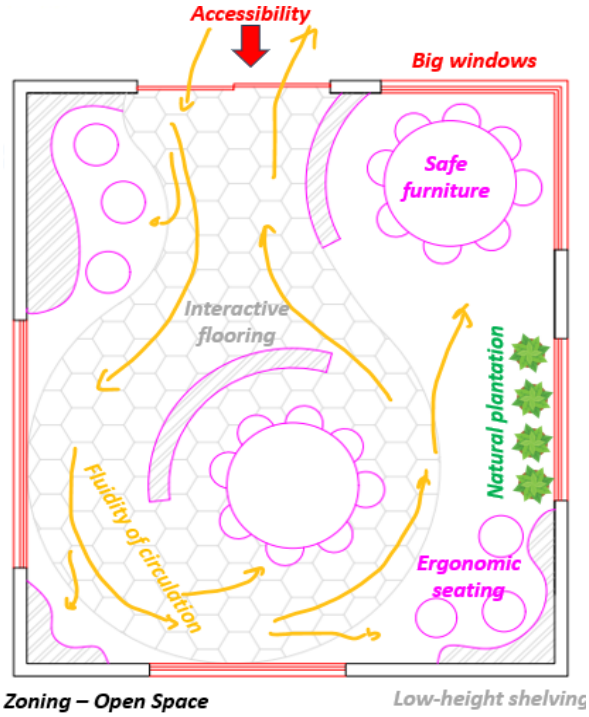
These findings are also supported by benchmarking analysis, which reveals that classrooms with pre-defined areas, fluid circulation, and natural elements positively impact children's autonomy, wellbeing, and confidence. Moreover, interactive floorings and accessible shelving were also found to have a huge effect on the toddlers' independence.

Collectively, the above results confirm that the physical environment is not just a minor design aspect, but it is a crucial factor that supports the Montessori pedagogy.

5.3. Design Recommendations

Hence, these research findings are used to identify a set of design strategies that cohere in supporting Montessori principles to enhance safety, autonomy, and engagement for toddlers. The setting within a nursery classroom should have clearly defined zones, differentiating various functional areas like creative work, open-floor playing, reading, and sensory exploration, while keeping open visual boundaries that facilitate both independence and supervision. Large windows shall be supported to maximize natural lighting, and soft artificial lighting is intended to be used only when necessary to foster calmness and maintain high levels of engagement in the main activity zones. To boost autonomy, Furniture should be child-scale and ergonomically appropriate and stable; and to enhance independence, lower open shelving is recommended. To improve toddlers' comfort, engagement, and autonomy, the interior environment needs to be uncluttered, spacious, and well-organized. Interactive, durable, and colorful flooring may be used to define activity areas, enhance toddlers' motor and creative skills. Free and fluid children's circulation is ensured through predefined circulation paths, avoiding visual barriers and congestion that may block teachers' supervision. Finally, the use of natural greenery can be promoted by incorporating well-designed and accessible plant corners that can contribute to exploration, emotional, and environmental awareness. It must therefore be noted that all these recommendations provide a well-balanced framework in ensuring a safe and responsive classroom environment.

The proposed classroom design is deliberately organized to meet the Montessori design considerations by clearly establishing different functional activity spaces for concentrating, transitioning, and avoiding overstimulation. There is sufficient natural illumination provided by means of large and optimally positioned windows that effectively light up main activity spaces and hence redirect the focus away from the necessity to employ artificial sources of light. All the furniture and storage shelves are standardized to meet child-scale design, thereby providing safe, rounded, and stable objects, open shelves are set at the toddler's eye level to promote independence and orderliness. The interior space is open and spacious, it is also designed to avoid overcrowding and visual disarray, thereby promoting concentration and facilitating teachers' surveillance. Interactive flooring, hence, the use of cushioned floor mats and colored rugs, is used to demark activity spaces and promote the development of the toddler's motor, creative, and social skills. The spatial design of the classroom allows for easy and safe toddler movement between activity spaces, in line with the 'freedom within limits' Montessori approach to toddler development. Adding green touches, such as designing plant corners, helps to provide the toddler with exposure to the outdoors, benefits emotional adaptation and development, and promotes their initial understanding of the care required for living plants and hence the freshness of the interior space.



Note: Draft plan designed by Author

Figure (15): furniture plan for a typical classroom in a nursery

6. Conclusion:

This research reveals that the principles derived from the Montessori approach could be successfully transferred into guidelines on interior design that can be utilized for toddler classes. In that case, they could improve toddlers' independence, sense of responsibility, self-confidence, and overall comfort by implementing these guidelines appropriately.

However, this research included some limitations. The study will basically address the design guidelines for Montessori-friendly classrooms in nurseries for toddlers aged between one to

three years old. Therefore, the relevance to kindergarten design will not entirely be within this scope, considering the different sensory periods and developmental attributes presented by children aged between three to six years old. Also, because of time constraints, this proposed draft of space configuration is basically concentrated on the initial stage of space design (furniture layout) instead of a holistic interior design solution.

With these shortcomings in mind, there is a need for more research to be done. This would include studies that are longitudinal, in a natural setting, and would rehabilitate a currently existing nursery class according to a set of designed principles formulated from a Montessori approach. This would allow a more satisfactory assessment of the effect that this design would have on toddlers' comfort, autonomy, and self-confidence levels.

These recommendations can be considered to incorporate Montessori approach in interior design practice and to be enhanced in future studies.

Authorship contributions Statement:

Hana Karoui is a single author**;** she performed all research parts alone.

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Declaration of competing interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability:

Data will be made available on request

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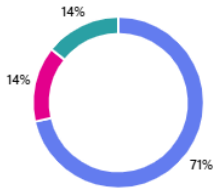
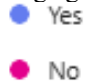
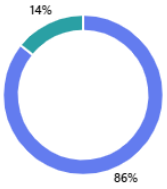
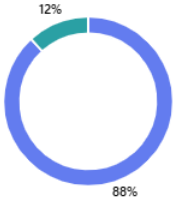
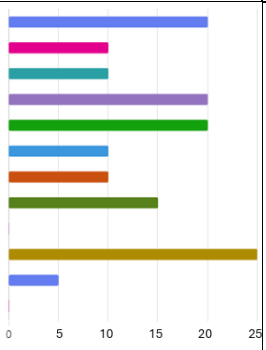
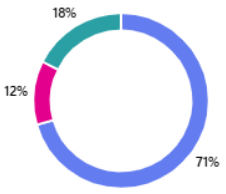
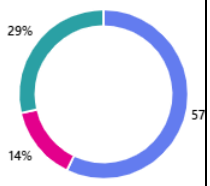
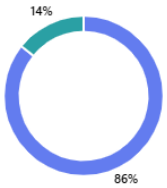
[62] "International School Brussels," [Online]. Available: https://internationalschoolsinbrussels.be/en/home/.

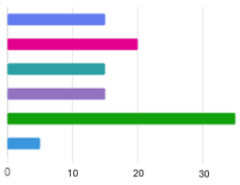
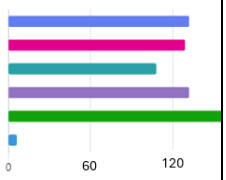
[63] "SPIENTA Montessori Nursery," [Online]. Available: https://sapientiamontessori.com/.

Appendices:

Appendices (A): Questionnaire results & Analysis

Montes sori key feature	Questionnaire attribute	Teachers' response	Parents' response	Questionnaire Analysis
Active movement	**Comfort aspects in classrooms** Q1: Do you believe that the interior environment of the classroom is c omfortable for toddlers 	 25 out of 35 teachers presenting 71% trust that comfort is a primordial measure that shall be applied in classrooms while the other 10 teachers presenting 28% of the total respondents suppose that other aspects shall be considered in the classroom such as safety and care	 145 out of 154 respondents presenting the majority of mothers (94%) believe that the key important criterion of selecting a nursery is the comfort of their toddlers in classrooms	Classroom comfort is greatly valued by both stakeholder groups. Mothers demonstrate a very high consensus of 94%, while teachers show a clear majority of 71%. About 28% of the teachers foreground safety and care, pointing out that while comfort is central, safeguarding aspect is still crucial in day-to-day classroom design.
Self-directed learning/ self-discipline	**Importance of independence and self-confidence for toddlers** Q2: Do you believe that it is important that toddlers need to be independent an d self-confident from a young age 	 30 out of 35 teachers (86%) are aware that self-confidence and independence are primordial skills that need to be taught in classrooms	 136 mothers presenting 88% of interviewees agree, same as teachers, that toddlers shall gain self-confidence and independence skills during their stay time at nurseries	Teachers and mothers consider self-confidence and independence both as fundamental developmental objectives in nursery settings. Therefore, it is essential to provide child-scaled furniture and open, reachable shelving for the children to enable self-initiated activity selection and return.
Sensory insights	**Types of activities practiced inside classrooms for toddlers** Q3: What kind of activities do you feel that your toddler needs to exercise at nursery?	 25 out of 35 Teachers (71%) observed that	 144 mothers presenting the	A clear majority of the teachers report that toddlers most often engage in dancing and singing (71%). Over half also observe interest in drawing and physical games (57%), indicating high salience of performing arts and gross/fine motor play

Montessori key feature	Questionnaire attribute	Teachers' response	Parents' response	Questionnaire Analysis
	Drawing & coloring clay modeling crafting sport physical games mental games cooking class English class Quran class dancing & singing puppet shows	toddlers are more likely to exercise dancing and singing inside the classrooms, also 20 teachers (57%) remarked that toddlers like to draw & color, exercise sport and do physical games.	majority of responses (93%) believed that drawing & coloring activities are very important, while 117 other parents (75%) thought that Quran class is an important activity, also a noticeable percentage of parents 144 presenting 74 % believed on the importance of clay modeling activity to improve child motor skills	in day-to-day classroom behavior. Therefore, it is essential to allocate a zone for Music and Movement which can be as Open floor area. It is also recommended to add an Art Corner using Child-height tables.
Freedom & responsibility	**Accessibility to shelves** Q4: Do you believe that it is important for toddlers to get easy access to all shelves inside the classroom Yes No Maybe	 25 out of 35 respondents presenting the majority of teachers (71%) are aware that toddlers shall have their freedom to access to shelves where they can arrange back their toys after use	 88 out of 154 mothers (57%), who believe that access to shelves may cause harm to their kids if any incident happens	Teachers (71%) favor open shelf access to build toddlers' independence and responsibility, whereas a majority of mothers expressing concern (57%) emphasize potential harm from incidents. Practically, the nursery can reconcile autonomy and safety through low-height, rounded-edge shelving; and circulation.
Observation	**Classroom Safety** Q5: Do you believe that Safety needs to be considered in the design of the classroom Yes No Maybe	 33 out of 35 teachers presenting almost all interviewees (94%) believe that safety is the primal factor to be studied in a classroom	 132 out of 154 Mothers (86%) do agree with the same position of teachers regarding safety measures precautions	Safety is overwhelmingly emphasized by teachers and mothers in nursery classrooms. Almost all teachers (94%) endorse safety as the primary factor, and an overwhelming majority of mothers (86%) agree with emphasizing safety precautions. In practice, design should embed "safety first" standards into furniture specification and circulation.

Montessori key feature	Questionnaire attribute	Teachers' response	Parents' response	Questionnaire Analysis
Environment	**interior design of classrooms** Q6: What's the important factor that shall be considered in the interior design of the classroom Big windows (Sunlight is pri Colorful & Interactive floori Shelving (organizing as key Indoor plantation Safe Furniture (made out of and rounded corners) Others	 All 35 teachers (100%) agreed that using safe furniture, most specifically those made of soft materials with rounded edges, is a crucial determining factor for classroom interior design considerations. Moreover, 20 teachers (57%) agreed that using colorful floor surfaces is significant in facilitating reduced inactivity among toddlers in the classroom setting. In addition, 15 teachers (42%) agreed that installing shelves would be advantageous for improving children's ability to organize, while equal numbers (42%) of teachers agreed that Indoor plants are a necessary source of greenery in a classroom to contribute to a toddler's well-being, and that Natural light also plays a significant part in improving a toddler's well-being in a classroom setting.	 Out of a total of 154 participants, a vast majority of mothers (142, 92%) stated that access to safe furniture pieces represents an essential aspect in designing a classroom. In addition, 120 parents out of a total of 154 participants (78%) stated that large windows influence their toddlers' mood and participation while in the classroom. In a similar fashion, 119 parents out of a total of 154 participants (77%) stated that colorful rugs help create an interactive environment for learning. Furthermore, 121 parents out of a total of 154 participants (79%) reiterated the importance of indoor plants for the sole reason of improving a classroom environment. Finally, a total of 99 parents out of 154 (64%) placed importance on a systematic classroom design through shelving units at the sides of a classroom.	In reference to both teachers and parents, safe furniture is a common ground for a toddler classroom design. Socially, parents are far more concerned about environmental qualities like natural light and plants, and visual interest like colorful surfaces; conversely, organizational elements like shelving are valued but to differing extents by both stakeholders. Collectively, these shared concerns imply a design process where safety precedes daylighting and bioelement integration, then color zoning, and lastly organizational furniture with a design emphasis on pedagogical appropriateness, durability, and safety for toddlers.