

# **Educational spaces: The Transformation of Dutch Montessori School Architecture Throughout the 20th Century.**

**A paper about the research of Montessori school architecture throughout the 20th century.**

**AR2A011 Architectural History Thesis**

**Msc 3 Architecture, Technical University of Delft**

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## **Summary**

Over the 20th century, Dutch Montessori school architecture evolved from teacher-centred to child-centred spaces that are in harmony with Maria Montessori's pedagogical vision. This paper conducts research using a literature review and a case study of the 1e Montessorischool the Wielewaal (1927, Dienst der Publieke Werken), the Arnhemse Montessorischool (1953, Piet Leupen), and the Amsterdamse Montessorischool (1983, Herman Hertzberger) to find an answer on the following research question: "How did the architecture of Dutch Montessori school buildings, in particular spatial design, evolve in response to Montessori pedagogical principles throughout the 20th century?" Key findings in this study are principles such as the prepared environment, freedom of movement, hands-on learning, mixed-age grouping, and uninterrupted work periods influence educational design. Spatial designs evolved from simple open spaces to more detailed and thoughtful ones. In 1927, the focus was on bright, shared and practical areas. By 1953, spaces became more flexible and kid-friendly, feeling warmer and more personal. By 1983, designs were complex, with different areas and features that encouraged social interaction, fully matching Montessori's ideas.

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## **Keywords**

Architecture, Montessori school, pedagogical principles, spatial design, prepared environment, etc.

## **Introduction**

Throughout the 20th century, Dutch educational architecture underwent transformations such as a shift from teacher-centred layouts to child-centric spaces, especially in the design of

Montessori schools. (Jurczuk, n.d.) Montessori classrooms can be larger than traditional classrooms, and these spaces are organised and zoned rather than orientated towards a board at the front of the room. The child is the focus of the classroom, not the educator. Montessori education underwent important developments within its pedagogical principles, influencing how educational spaces were conceptualised and constructed. (Jurczuk, n.d.) Because the world is consistently evolving, Montessori schools are, too.

To study this transformation, this research will focus on Montessori schools built in the 20th century in the Netherlands, as they provide a unique context to examine how these school buildings adapted or evolved their spatial design to reflect and support these developing pedagogical principles. Furthermore, this paper will also examine whether these evolved spatial designs support the Montessori pedagogical principles in practice or if they remain theoretical or symbolic architectural concepts. The research question is:

*“How did the architecture of Dutch Montessori school buildings, in particular spatial design, evolve in response to Montessori pedagogical principles throughout the 20th century?”*

The main question is answered by answering the following sub-questions:

1. What were the important Montessori pedagogical principles that influenced the understanding of educational spaces?
2. How did the Dienst der Publieke Werken (1927), Leupen (1953) and Herman Hertzberger (1983) translate Montessori principles into architectural design elements in their school projects?

Each sub-question will be addressed separately in the results. After defining the sub-questions, the main question is answered in the conclusion.

## Methods and materials

The main question is examined on the basis of two sub-questions. The overview below describes how each sub-question contributes to answering the main question and which research methods are used for this.

1. The first sub-question focuses on research of the Montessori pedagogical principles through a literature study of sources related to Montessori education, including books, academic papers, and relevant websites.
2. The second sub-question focuses on the research of the Montessori principles in three school projects of the 20<sup>th</sup> century through a case study and an interview.

These school projects are:

1. Montessorischool the Wielewaal (1927) – Ad Grimmon - Dienst der Publieke Werken
2. The Arnhemse Montessorischool (1953) – Piet Leupen
3. Amsterdamse Montessorischool (1983) – Herman Hertzberger

An analysis will be done on these three Montessori schools where there will be looked at the architectural program and the spatial design of these buildings and how they embody the

Montessori pedagogical principles. The study will include a comprehensive review of architectural floor plans of the classrooms, shared spaces and a collection of site photographs to visually support the case studies. Furthermore, site visits and interviews with the current principals or tutors of these schools will be done. These interviews will explore their perspectives on whether the school designs truly support Montessori principles in practice and determine if they function as intended or remain as theoretical concepts of the architect without successful implementation.

## Results

### 3.1 The Montessori pedagogical principles

The Montessori principles came from Maria Montessori, and she was an Italian physician, educator, philosopher and innovator. This doctor of medicine, the first female doctor in Italy, had developed a sensational teaching method. This method meant a complete break with traditional primary education, where children sat upright in the desks all day long listening to what the teacher had to tell them. Montessori also eliminated the traditional nursery schools. There, children who were still too young for primary school were literally supervised and kept entertained without learning opportunities. In addition to intellectual development, Montessori attached great importance to physical and sensory development. For this purpose, she developed special teaching aids and that's why the interior of the classroom also had to meet certain requirements (Calis, 1996).

The educational philosophy of Maria Montessori brought a big revolution to the learning environment and the way we think about it. At the core of her pedagogical principles lies the emphasis on the child's natural drive for self-development, which is captured in one of her famous phrases, "Help me to do it myself" (Nederlandse Montessori Vereniging, n.d.).

Maria Montessori's educational method is used today in a large number of public and private schools throughout the world. Her pedagogical principles are scattered across her different books, as she developed her philosophy through observation and practice rather than presenting them in a single definitive list. Various sources related to Montessori education, such as the Montessori Academy, Times Montessori, and the American Montessori Society, have compiled these principles. These principles are still the same ones that Maria originally came up with and wrote about in her books, such as *The Montessori Method* (1909), *The Secret of Childhood* (1936) and *The Absorbent Mind* (1949). They are largely the same as those she originally wrote in her books, with only minor changes in wording or application for modern contexts. It's worth mentioning that modern applications, like incorporating nature education or sustainability, are extensions of her original ideas, not new principles. This means her focus on child-centred, natural development is preserved, even as educators adapt to contemporary needs.

These are the key principals and their impact on the educational environment:

1. **The prepared environment** (*Key Montessori Principles Of Education* | Montessori Academy, n.d.; Stark, n.d.)

Pedagogical principle: The learning space is carefully structured, accessible, child-sized, and everything has a purpose and a place to foster order and independence. The prepared environment activates a love of learning through curiosity, stability, and freedom.

Impact on the space: Classrooms should have large windows for plenty of natural daylight and an organised layout with spatial zoning supporting exploration, concentration and curiosity. The furniture should be child-scaled, movable, open and lightweight with accessible materials on the shelves. All of these measurements ensure adaptability and autonomy, leading to a functional environment for independent learning.

2. **Freedom of movement and choice** (*Key Montessori Principles Of Education | Montessori Academy, n.d; Stark, n.d.*)

Pedagogical principle: Montessori believed that education should revolve around the needs of the child, not the teacher. They learn best when they have the freedom to move and explore in a space that fits their scale. This approach respects their independence and encourages self-directed learning.

Impact on the space: Classrooms are designed with light, child-sized furniture (small tables, chairs, and shelves) to make materials accessible. The open and flexible layout with smooth circulation paths supports freedom of movement, so children can navigate the space comfortably and independently. Rooms that are connected make peer interaction across the space possible, and outdoor access enables an extended classroom environment where movement and freedom continue seamlessly.

3. **Hands-on learning** (*Key Montessori Principles Of Education | Montessori Academy, n.d; Stark, n.d.*)

Pedagogical principle: Maria Montessori observed that children go through unique developmental stages, which she called sensitive periods, and that's when they are especially open to learning particular skills or concepts. Characteristics of these sensitive periods include intense focus, repetition, commitment to a task, and greatly extended periods of concentration. That's the reason why a Montessori teacher should prepare the environment to meet the developmental needs of each sensitive period.

Impact on the space: Classrooms are designed for hands-on learning. There are sensory zones with different textures and materials that spark curiosity and deepen learning. There should also be a possibility for floor-based activities such as using work mats, while large table surfaces support group and individual projects. This also includes that the classroom should have built-in features such as child-height sinks, kitchenettes or art stations to encourage independence and practical tasks. Not only that, children could even learn through material textures used on the interior walls to stimulate the senses and invite exploration.

4. **Uninterrupted Work Periods** (*Key Montessori Principles Of Education | Montessori Academy, n.d; Stark, n.d.*)

Pedagogical principle: Montessori believed that children thrive in an orderly and simple environment. A clutter-free, organised space helps children focus, reduces overstimulation, and creates a calm, peaceful atmosphere for learning. This motivates children to work at their own pace by respecting their individual learning styles. During this time, they select and complete tasks without interruption, building coordination,

concentration, and independence. The cycle involves choosing an activity, engaging with it, cleaning up, and selecting a new task.

Impact on the space: The architecture should create spatial serenity and a minimalist spatial composition by avoiding bright colors and excessive decorations. This helps to focus and avoids visual overstimulation through minimal use of color and decoration. Built-in or neatly integrated storage, so materials are always organised and accessible. Every element in the room is intentional, which creates a peaceful atmosphere where children can fully immerse themselves in their work.

5. **Mixed-Age Grouping** (*American Montessori Society, n.d.; Stark, n.d.*)

Pedagogical principle: This principle is organised by grouping children strictly by age; Montessori classrooms bring together children in broader developmental stages, typically three-year age ranges, like 3 to 6 years old, which fosters peer learning and collaboration across different ages. In this way the Montessori classrooms are divided into mixed-age groups. Students stay in one class for the complete three-year cycle. The learning environment brings together children of different ages that promote cooperation, peer mentorship and social growth.

Impact on space: The space must support multi-functionality and flexibility. This means environments that encourage interaction, such as shared communal areas or open plans, instead of separate rooms, to support social dynamics and mixed-age activities, should also have built-in nooks or quiet spaces to give children the option to step back while remaining connected to the collective environment.

**Outdoor environment** (*Montessori, 1909, p. 192-204*)

Although Montessori didn't define the outdoor environment as a separate principle, nature still plays an important role in her philosophy. She believed that being in nature helps children feel curious, mindful, and have environmental responsibility. Outdoor spaces are seen as an extension of the classroom, places where learning happens through movement, observation, and hands-on experiences with living things.

The key Montessori principles that have an influence on the spatial design of educational buildings are the prepared environment, freedom of movement and choice, hands-on learning, uninterrupted work periods, and mixed-age grouping. By making these changes in the spatial design, the focus shifts to the intellectual, physical and sensory development of the child. There are significant overlaps between these principles, as they all focus on child-centred spaces that encourage independence, curiosity, and natural development. For example, the prepared environment supports freedom of movement, while hands-on learning materials are important to both the prepared environment and uninterrupted work periods. Similarly, mixed-age grouping works together with freedom of choice to promote peer learning and social development. Although Montessori didn't explicitly define outdoor environments as a separate principle, nature and outdoor experiences are integrated throughout her educational philosophy. According to her, kids develop better when they engage with the outdoor environment. This approach ensures that Montessori spaces, whether indoor or outdoor, are designed to respect children's developmental needs and support their drive for self-directed learning.

### 3.2 Montessori schools throughout the 20th century

For this subquestion a case study on the selected projects will be executed based on the Montessori pedagogical principles from the first subquestion. The analysis will begin with a historical overview and contextual background of the school, followed by an in-depth examination of the project itself. At last, through interviews with teachers and principals, this subquestion will cover the school's practical implementation of these principles and evaluate the effectiveness of the measures taken.

#### 1. Montessorischool De Wielewaal (1927)

##### **History and context:**



Figure 1; The Wielewaal School (Gemeente Amsterdam, n.d.)

On the 22nd of October the first public Montessori school opened in the Netherlands. The Wielewaal school was built in 1927 by the Publieke Dienst der Werken. Before the foundation of this school, there were serious discussions that came up (Calis, 1996). In 1912, the Netherlands first heard of Maria Montessori, born in Italy in 1870. The Montessori method was a great success with parents who had long been horrified by the existing education system. A number of them took matters into their own hands. In The Hague, the first Montessori nursery class was founded in 1914. In Amsterdam, this was done in 1916, and these preparatory schools (at that time, nursery schools were not yet mentioned) were therefore private schools, funded by the parents themselves. This new method also had many opponents, and for a long time, the tempers of many teachers, pedagogues and administrators became heated whenever this revolutionary method was discussed (Calis, 1996).

The Amsterdam city council also considered this new education and if it should have been supported or not. It was decided to give Montessori education the benefit of the doubt. In 1917, a Montessori trial class was started in the municipal preparatory school in Hasebroekstraat in the West. Two years later, the mayor and aldermen sent a committee to London to test Montessori education in practice. In February 1920, the committee advised giving the Montessori method in preparatory education “a fair chance” and to expand the trials in preparatory education. However, the proposal for a public primary Montessori school had to remain on the shelf until there were sufficient qualified Montessori teachers. The association now decided to continue with its plans, and in October 1920, the Amsterdam Montessori School opened at De Lairesestraat 157, the first private primary Montessori school in Amsterdam (Calis, 1996).

Since 1922, lessons had been given entirely according to the Montessori method. The parents also wanted to try out the Montessori method in primary education. They wrote to the mayor that they had so much confidence in the method that they would consider it a great blessing for their children, who are now leaving the preparatory school, to also receive public primary Montessori education. They therefore regretted very much that there was no public primary Montessori school in Amsterdam. At the insistence of Eduard Polak, alderman for education since 1923, the municipal council considered this request, despite the reluctance of the aforementioned municipal committee. In the meantime, the council had decided, in response to a request from the parents, that the Helmersschool (Eerste Helmersstraat 271) would be allowed to run a trial class for primary Montessori education as of September 1924. Only children who had attended a preparatory Montessori school and whose parents had given explicit permission were admitted here. This positive decision may have been partly inspired by the visit that Maria Montessori made to the Netherlands from November 1923 to February 1924. She gave various courses and lectures there (Calis, 1996).

After the municipal authorities had given permission for the establishment of this Montessori trial class, interest steadily increased. In the meantime, the SDAP education committee was busy with its research on new forms of education focusing on Montessori and Dalton systems. The Dalton method was seen as less radical, allowing individual work within a structured environment and maintaining traditional class lessons. Committee members Adelaar-Fürth and Van Gogh-Wibaut supported Montessori education, believing it could help build a truly socialist society. However, others, like Theo Thijssen, were sceptical. They felt that the so-called freedom in Montessori education concealed a "strong suggestive element" and preferred direct guidance from teachers. Thijssen also missed the "warm social atmosphere" he deemed essential in schools. In September 1924, the SDAP committee presented a preliminary report. It stated that Montessori education was not eligible for public education but should remain private for the time being. Adelaar-Fürth protested against this. She did not agree with this statement and wanted to mention this in a separate appendix that her conviction that Montessori education is particularly suitable for preparing a truly socialist society is stronger than ever (Calis, 1996).

No matter how great the division within the parties, public Montessori education was expanded. On 22 April 1925, the first public preparatory Montessori school opened. At Hygiëaplein 14. This nursery school was fully equipped according to Montessori principles. Alderman Polak strongly praised Montessori teaching methods and the people who supported them during the opening speech of this school. He explained that parents from all backgrounds—not just intellectuals—wanted this type of education for their children, which convinced city officials to back the approach and even plan a new Montessori primary school. In March 1926, the city council voted on this first public primary Montessori school, to be built in the extension of the Jan van Eykstraat, and on the 22nd of October, the school officially opened (Calis, 1996).

## Analysis – Montessori principals and architectural program

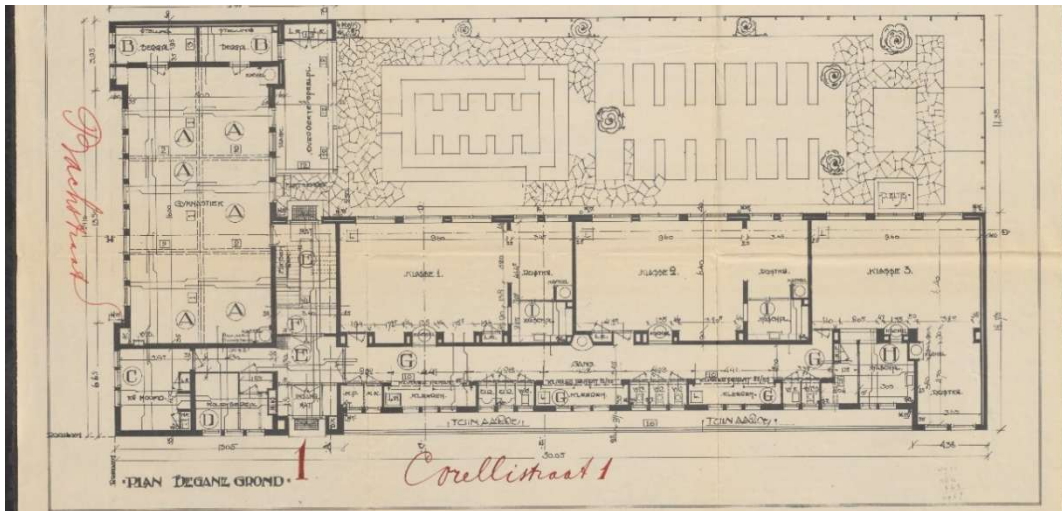


Figure 2: Floorplan of groundfloor – Toilets are opposite of the classrooms (Gemeente Amsterdam, n.d.)

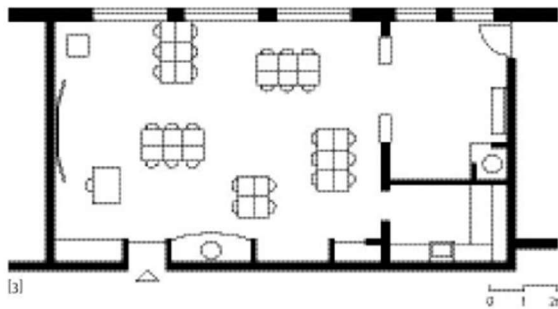


Figure 3: Floorplan Classroom – Layout of the classroom (Hertzberger, 2008, p.26.)



Figure 4: Kitchen space – Shows the kitchen area in the classroom (Hertzberger, 2008, p.27)

### Classroom layout

The spacious classrooms of 95 m<sup>2</sup> embody Montessori's prepared environment principles by featuring an open layout that encourages freedom of movement and independent exploration through smooth circulation paths (figure 3). Each classroom is provided with a 'resting space', a side area that is like a seating area. This area is located at the back of the classroom and separated from the main classroom by a passage. Fixed benches with cushions are placed to lie down or read, and a child can withdraw themselves here from the dynamic atmosphere of the classroom to concentrate on their work. A sheet can also be hung in the passage so that behind it plays and sketches can be prepared unseen by others, thereby creating creativity and self-expression. When these are enacted in front of the class, the sheet can become a stage curtain.

The absence of fixed workstations within this multifunctional area aligns with Montessori's emphasis on adaptable learning spaces that can be adjusted to meet a child's changing needs and interests. Interconnecting doors in the corners of the rooms between neighboring classrooms also promote social interaction and collaborative learning, enabling kids to interact with friends and peers in various settings and enhancing their educational experience. The spaces intended for the stoves have been transformed into multipurpose areas for the kids over time. This space

serves as a work area, a rest area, or a nook in the wall where kids can work or read together. The year this intervention took place is unknown (figures 5 and 6).



Figure 5: Transformed area – Nooks in the wall for reading (photo by Amarja.)



Figure 6: Transformed area – Playing corner in the back of the class (photo by Amarja.)

## Shared Spaces

The interior of the building has soft, neutral colors to create a calm and welcoming learning environment. The wide hallway (approx. 2.5 m wide) separates the classrooms from the nearby toilets, giving children a comfortable, home-like feeling since they don't have to walk far and everything is close by. This hallway also serves as a shared workspace where children can collaborate, promoting social interaction. Clothing racks in the hallway have animal tiles above each one, helping children learn organisation and responsibility. The openness of the hallway and width contribute to a spacious and inviting atmosphere, encouraging mobility and exploration.

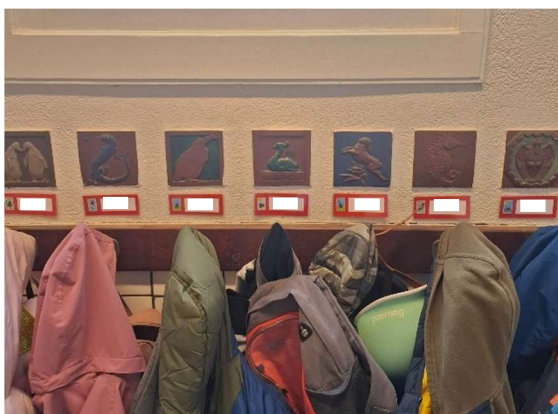


Figure 7: Clothing racks with animal tiles (photo by Amarja.)



Figure 8: Hallway across the classroom – Shared space (Hertzberger, 2008, p.26.)

## Outdoor environment

The building is designed to connect closely with the outdoors, aligning with Montessori's emphasis on integrating nature into the learning environment. From the outside, the school may

appear dark, but once you step inside, you realise that's not the case; the classrooms are filled with natural light due to large windows overlooking the garden. These windows not only provide the space with natural daylight but also connect the children with nature, which can enhance focus and well-being. Low windowsills adorned with plants create inviting spots where children can stand/sit, care for the plants, and feel connected to the outside world. In every classroom these low windowsills vary in height depending on the child height. This design fosters a calm and focused atmosphere, supporting effective learning.

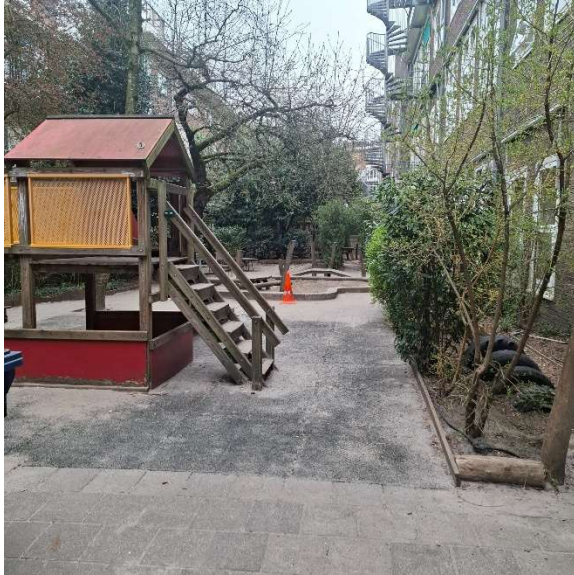


Figure 9: Outdoor garden (photo by Amarja.)



Figure 10: Large windows with a view of the garden– (photo by Amarja.)

## Furniture

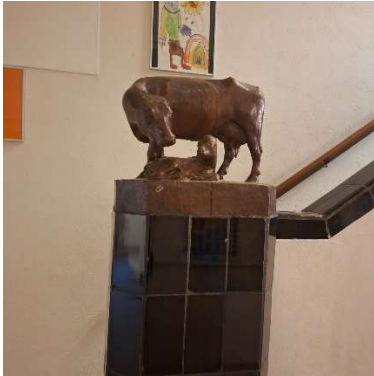
In each of the classrooms is a kitchen space where water could be splashed around and watering cans could be filled to water the plants each child has to look after. The large low-lying sink unit means that the children are free to go about painting and modelling with clay independently. All the furniture in the classroom is child-scaled, lightweight and accessible, which supports the principle of the prepared environment.

## Concept

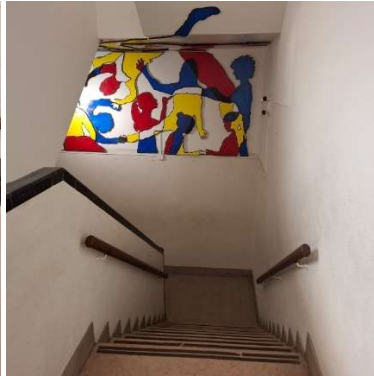
Montessori's focus on fostering children's independence was reflected in practical architectural solutions. For instance, low sinks, coat racks, and toilets were strategically placed opposite the classrooms (figure 2), allowing children easy access and encouraging independence. Moreover, the design choices aligned with the era's emphasis on hygiene and health. The focus on a sanitary environment was not only an architectural consideration but also embodied Montessori's idea to create a healthy learning space for children.

Furthermore, placing the focus on including household activities in the classroom setting allows children to engage in practical life tasks, mirroring responsibilities they observe at home. Giving each child their own desk or space helps them feel responsible for it and motivates them to keep their work environment organised and clean.

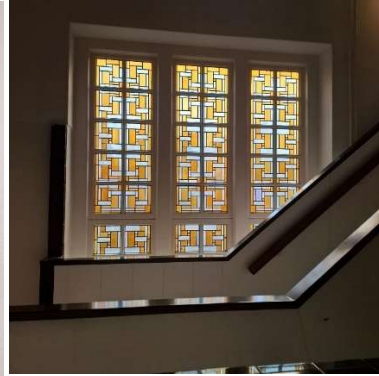
The Wielewaal School was built in the style of the Amsterdam School, and you can really feel that influence inside the building. Around the central staircase, there's a strong artistic presence with built-in artworks and expressive paintings (figures 11 -12). Even in the hallway above the clothing racks there are beautifully crafted tileworks, which also work as a creative way for children to learn (figure 7).



*Figure 11: Art piece next to the staircase (photo by Amarja.)*



*Figure 12: Painting next to the staircase (photo by Amarja.)*



*Figure 13: Stained glass next to the staircase (photo by Amarja.)*

### **Practical implementation and evaluation:**

In an interview with director Sandra van der Meulen and deputy director Samantha Sabbé of the Montessorischool De Wielewaal, it became known that they are very proud of this school. This design of Publieke Dienst der Werken and architect Ad Grimmon works in practice more so since Maria Montessori had visited this school herself and gave her insights about the design of the school.

The main thing which they are not happy about is that there isn't a big communal area where everyone can get together, so they use the gym hall for certain occasions but have to split the students into groups because not everyone can fit in together. Now they have applied for a bigger gym with separate changing rooms for boys and girls because this aspect wasn't included in the original design. During the interview with Sandra van der Meulen, it was mentioned that the building has undergone several renovations over the years, but the main staircase has remained largely untouched, which could be seen by the deep dents in the stair threads, revealing its age and long-term use. However, the staff is concerned about the lack of safety regarding the void between the staircases. There have been no accidents so far, but they are still worried about the open space and the risk of falling due to the complete lack of protective barriers.

Despite these concerns, the overall design continues to function well in daily practice and is considered highly effective in supporting the key Montessori pedagogical principles which were discussed in subquestion 3.1. According to van der Meulen, all core principles of the Montessori method are clearly reflected in the architectural design of the school, creating an environment that supports children's learning and development.

## 2. De Arnhemse Montessorischool (1953)

### History and context:



Figure 14: The Arnhemse Montessori school (Changer, n.d.)

(Derks-Verhey et al., 1997) Marre Matthes, one of the three founders of the Arnhemse Montessorischool, graduated in the year 1933. She even followed lessons from Maria Montessori herself for several months in Barcelona on an excursion. After her graduation she wanted to do something with toddlers, so when she arrived back in the Netherlands, she heard from a few acquaintances that they wanted to found a school. Marre Mathes persuaded them to found a Montessori school.

In the year 1935 Miss Marre started on her own, with financial help from her father, a nursery class at Van Ruysdaelstraat 76. She started with 10 children first, and she made all the school materials herself based on the Montessori idea since no one wanted to help her at that time. In 1936 the building next door had to be rented, and after two years the school grew so fast that even parents wanted a Montessori primary school for their children. All necessary steps were taken to achieve this. In the meantime, a suitable building was sought in the center and in the various neighbourhoods around it to set up Montessori nursery schools (Derks-Verhey et al., 1997).

(Derks-Verhey et al., 1997) In 1937, the foundation deed was finally signed, officially establishing the Arnhem Montessori School. Since then the school has been housed in various buildings throughout the neighbourhood. The press also paid attention to the establishment. Eventually Marre Matthes got a board, and in cooperation with the members, she got support with various school problems. At that time it was still a school without subsidy. It also happened that the board called the parents together to fund the school by collecting money, and in that way, the school was saved. There were still classes at various addresses, including Jan Vethstraat 16, Van Goyenstraat 3 and also Van Lawick van Pabststraat 31 and Pels Rijckenstraat.

In 1947, a total of 76 children were registered. With all their might, they tried to prove the school's right to exist to the Board of Mayor and Aldermen. This was difficult because the school was located at multiple addresses. They also had to plead passionately for the purchase of furniture. From that time on, the desire for a school building arose. Finally, the mayor and aldermen became

convinced of the need for Montessori education in Arnhem. The subsidy for the construction of a school building finally arrived (Derks-Verhey et al., 1997).

In the meantime, architect Leupen was commissioned to design the school. In the 1950s, a significant milestone was reached when the first stone of the school building was laid at the Nicolaas Maesstraat. Over the years, the school continued to grow, and the original four classrooms were expanded to include two additional classrooms in 1953. In 1974, architect Godthelp designed a 3-classroom nursery school was built next to the school building (Derks-Verhey et al., 1997).

### Analysis – Montessori principals and architectural program

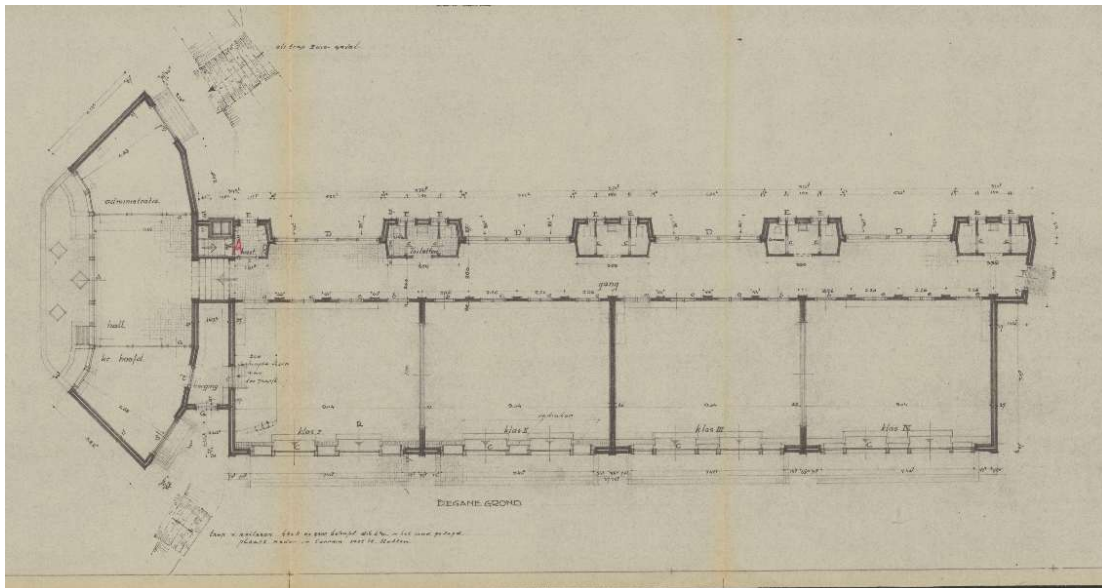


Figure 15: Floorplan of the Arnhemse Montessori school – Hallway with outer nooks divides the classrooms and toilets (Gelders Archief, n.d.)

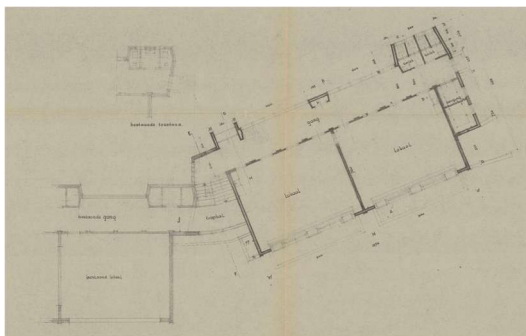


Figure 16: Expansion of the Arnhemse Montessori school in 1953 (Gelders Archief, n.d.)

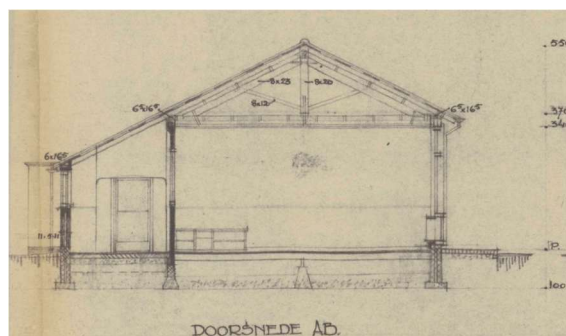


Figure 17: Section of the Arnhemse Montessori school in 1953 (Gelders Archief, n.d.)

### Classroom lay-out

The classrooms of 65 m<sup>2</sup> with a height of 3.4 m have a flexible open layout with large windows where abundant natural light flows in. These windows have low windowsills which are transformed into sitting areas or places where children can rest or read during the day. The circulation path in the room is fluid and with movable furniture, floor-based activities can take place. However the classroom is a bit small for 30 children especially when these floor based-activities need to take place, so children can't really move freely in this aspect. Due to lack of

space, children and teachers made some space in front of the class for displaying their work (figure 28) which is a very important aspect of the Montessori education.



Figure 18: Classroom layout (photo by Amarja)



Figure 19: Kitchen (photo by Amarja)

## Shared spaces

The classrooms are separated from the outdoor nooks by a broad hallway of 2.6 m (figure 21). The nooks outside the classrooms are used as the prepared environment for the child. In this space there is a big table for children where they can do group work or other activities together or even sit alone to do their work. Opposite these nooks, children have their own clothing racks that are even scaled to their height to support independence. Next to the outdoor nooks and opposite the classrooms, the toilets are located. Over the years this building had some renovations, and some of the toilet spaces were converted to storage spaces and are now used as a workspace for children to get away from all the noise and fully concentrate. Outside the school building there is a square called the blue square (figure 29), and that's where all the children play together during the break, but this is also the place where presentations are being held, which is an important aspect of the Montessori education.

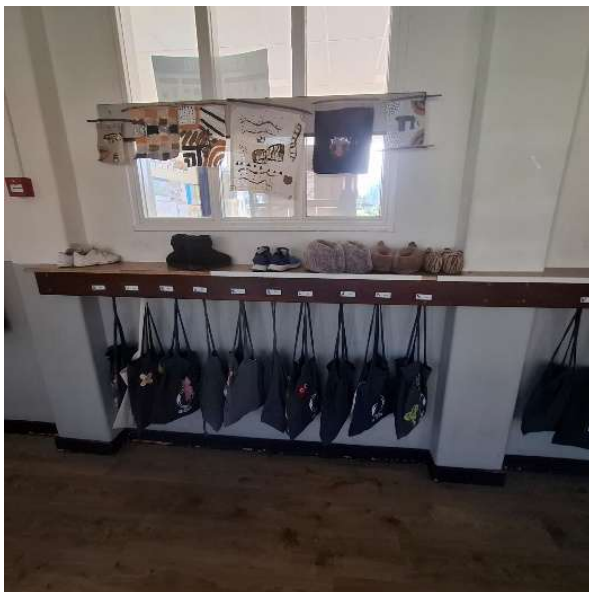


Figure 20: Child-scaled clothing racks (photo by Amarja)



Figure 21: Outer Nooks in the hallway (photo by Amarja)



Figure 22: Large windows and low windowsills (photo by Amarja)



Figure 23: Shared classrooms (photo by Amarja)

## Outdoor environment

Integrating low windowsills in classrooms not only provided the children with views of the outside world but also created additional informal workspaces at child height. Doors were also placed in every classroom with direct access to the garden. These details show how Montessori's emphasis on child-scaled environments, connection to nature and opportunities for independent learning was integrated into the building. Due to the big windows, the classrooms have a lot of natural light, creating a calm atmosphere for children to concentrate better in class. The outdoor environment is not only used as a garden or a playground for children but is also seen as an extended classroom, meaning that children are free to decide where they want to work, whether it's in the classroom or outdoors.



Figure 24: Outdoor space (photo by Amarja)



Figure 25: Outdoor environment (photo by Amarja)

## Furniture

The furniture are all lightweight and child-scaled, so they are all movable. In the back of the classrooms there is also a kitchen which encourages kids independency. In 2014 Studio E Interior made a new design for the entry hall of the school building; they designed new furniture which created a fluid circulation throughout the space. In this space children can meet with each other or sit together. The furniture is used for storage, as a clothing rack and as a step to sit.



Figures 26 & 27: New Furniture (Studio E-Interieur, n.d.)

## Concept

The Arnhemse Montessori school building is deeply integrated into the context of that area. The area has a hilly landscape, and it's clearly visible how the school has different levels and is surrounded by many stairs. The architect has tried to weave the landscape into the building through the many stairs around the building and the direct access to the outdoor environment from within the classrooms. Although it's not clear what the thoughts and ideas of architect Leupen were behind this design, the floorplan of this school building is a bit similar to the Wielewaal school. A broad hallway with outer nooks separates the classrooms from the toilets across from them. According to the history of this school, it was clear that this school had no subsidy in the beginning, so there could have been a tight budget for the design. Since the Wielewaal school was the first public Montessori school, many architects could have used this building as an inspiration for Montessori education.



Figure 28: Display area (photo by Amarja)



Figure 29: Blue Square (Changer, n.d.)

**Practical implementation and evaluation:**

In an interview with the director of the Arnhemse Montessori school, Ester Jobsen, it became clear that this design works for the Montessori education. A big problem the school has is that they don't have enough communal and workspace for the children. The school doesn't have an aula or room to hold presentations, which is an important Montessori principle, so they have to use outdoor spaces for that or use an empty space of another building. Sometimes classes need to communicate with each other to use a certain workspace because there is not enough for every class. Some of the storage spaces in the hallway have even been transformed to use as a workspace for the children. According to Ester Jobsen, the school only gets a certain amount of m<sup>2</sup> per child, and they need to have thirty children in each class to be able to pay all the other tutors. So it's difficult to get extra space or a new building from the municipality.

In the spatial design of the Arnhemse Montessori school, it could be seen that they integrated the school in nature. The access to outdoor spaces from within the classrooms where the children could play or even focus on their work places a strong emphasis on the principle freedom of choice and movement. The design supports the key principles of Montessori, but it is a small school, and there is not enough space for certain activities.

### 3. Amsterdamse Montessorischool (1987)

#### History and context:



Figure 30: (Gemeente Amsterdam, n.d.)

Recently the Amsterdamse Montessorischool (The AMS) celebrated its 100th-year anniversary. The AMS is a special school that has stood for true Montessori education for more than a century.

In 1916, Miss C.W. Tromp started a nursery class with 15 pupils at Van Breestraat 129. This was the beginning of the application of the Montessori method in Amsterdam. In 1920, this class moved to a new mansion at De Lairesestraat 157.

In 1935, De Amsterdamse Montessorischool built a new school at Albrecht Dürerstraat. This 'preparatory school' was intended for toddlers. The architect was W. van Tijen, who was awarded a 'Prix' d'Excellence for his design in Paris. The building was given the character of an open-air school, with a spacious garden facing south, balconies with flower boxes, a roof terrace and open-air classrooms.

On 24 November 1944, two secondary school buildings in the Euterpestraat, where the Gestapo was located, were bombed by the English. This happened near the Albrecht Dürerstraat. The devastation was extensive; only the skeleton of the nursery school (concrete and steel) was still standing. In 1945, the school was restored under the leadership of architect J. Baanders Jr.

There were advanced plans for a completely new school building in the Euterpestraat (now Gerrit van der Veenstraat). That is why the primary school classes (now middle and upper grades) left the building in the De Lairesestraat in the early 1960s and ended up in a temporary building on the Apollolaan, next to where the Hilton hotel is now located. However, the school in the Euterpestraat was never built.

Eventually, Herman Hertzberger was commissioned by the city of Amsterdam and built the two Apollo schools between 1980 and 1983. The Amsterdam Montessori School finally had its own brand-new school building.

#### Analysis – Montessori principals and Architectural program

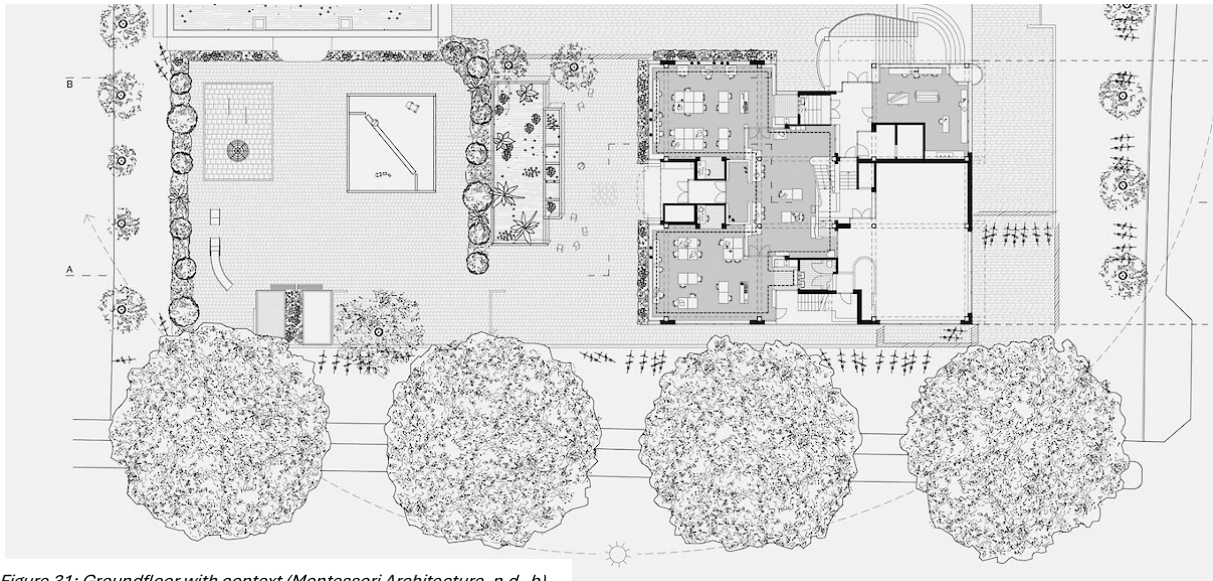


Figure 31: Groundfloor with context (Montessori Architecture, n.d.-b)

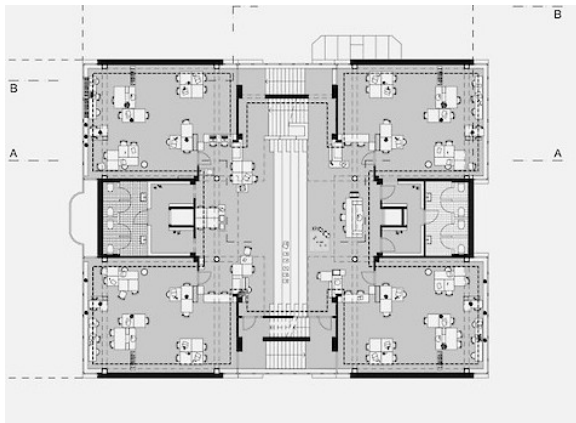


Figure 32 :1st floor (Montessori Architecture, n.d.-b)

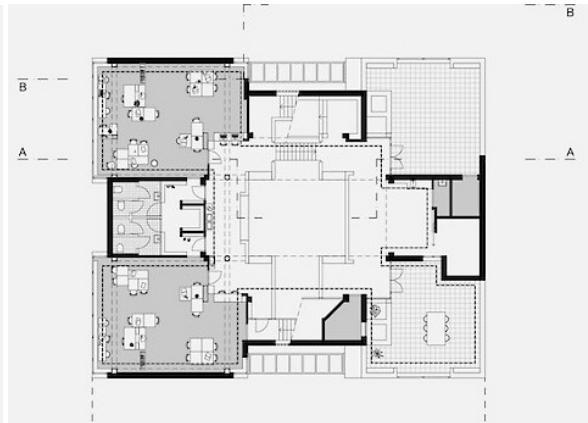


Figure 33: 2nd floor (Montessori Architecture, n.d.-b)

## Classroom layout

The classrooms, approximately 60 m<sup>2</sup>, features a flexible layout with movable furniture so that children can sit in groups or work individually, encouraging freedom of movement, one of the core principles of the Montessori approach. In the classrooms there are cosy nooks with built-in benches that provide quiet spots for reading or resting, which creates a calm and focused environment. There are also recessed wall alcoves containing low beds that offers younger students a quiet escape from the busy environment (figure 36). Large windows take up around 70% of the exterior walls, flooding the space with natural light and views of the garden, which reinforces a connection to nature. This blend of indoor and outdoor space enhances sensory engagement. Near the windows there are low windowsills which are used by the children to put their plants, and there are even some nooks around the windows to put gardening or cleaning tools, which are used by children to encourage independence and practical life skills.



Figure 34: The atrium (Montessori Architecture, n.d.-b)

## Shared spaces

The atrium is the heart of the school and is an interpretation of Montessori's 'prepared environment', where every architectural element serves as a learning tool with built-in seating, multi-levels, and carefully designed spaces for both individual and group work. The design transforms the entire school into a prepared environment, showing how architectural elements themselves became learning materials. Wide wooden steps serve as casual seating areas for assemblies or group activities, encouraging mixed-age learning as well. Classrooms connect directly to the atrium through glass doors, allowing students to flow easily between private and shared spaces.

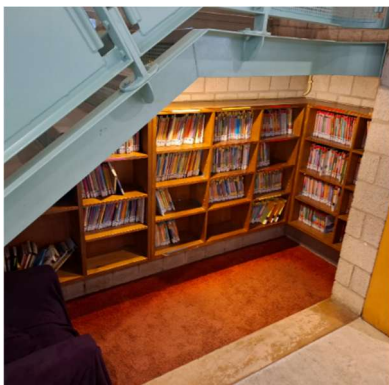


Figure 35: Nooks with a child-scaled library (photo by Amarja)

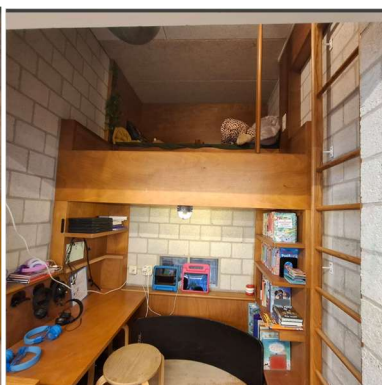


Figure 36: Nooks with a bed and working area (photo by Amarja)

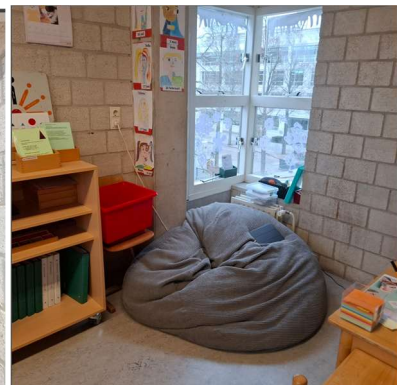


Figure 37: resting area (photo by Amarja)

## Outdoor environment

Through the large windows throughout the building, nature is integrated into the school, and even in the classrooms on the ground floor there is direct access to the garden. In spring and summer the outdoor garden is also used for children to grow flowers or vegetables, connecting them with nature through hands-on learning. The large classroom windows maintain a visual link to the garden, reinforcing this connection even indoors.



*Figure 38: Outdoor environment (Montessori Architecture, n.d.-b)*

## Furniture

The furniture throughout the school is designed by Herman Hertzberger himself and scaled to children's sizes, encouraging independence and supporting Montessori's idea of a "prepared environment". Tables and chairs made of lightweight wood can be easily moved around to support both group and solo work. In the atrium there is furniture for children to sit alone or in pairs to avoid crowding. Storage is open and child-accessible, making it easy for students to take and return materials on their own. Where the furniture in the atrium is placed, there are wooden railings featuring small gaps or openings, allowing for clear sightlines and easy oversight of the entire space from any angle (figure 34).

In hallways, low benches invite casual social interaction without crowding, while display cabinets near classroom entrances highlight student projects, encouraging curiosity and pride in their work (figure 42). Each classroom also features a small kitchen with a low sink and plant shelves, promoting responsibility through daily care tasks.



Figure 39: Kitchennette (photo by Amarja)



Figure 40: Classroom layout (photo by Amarja)

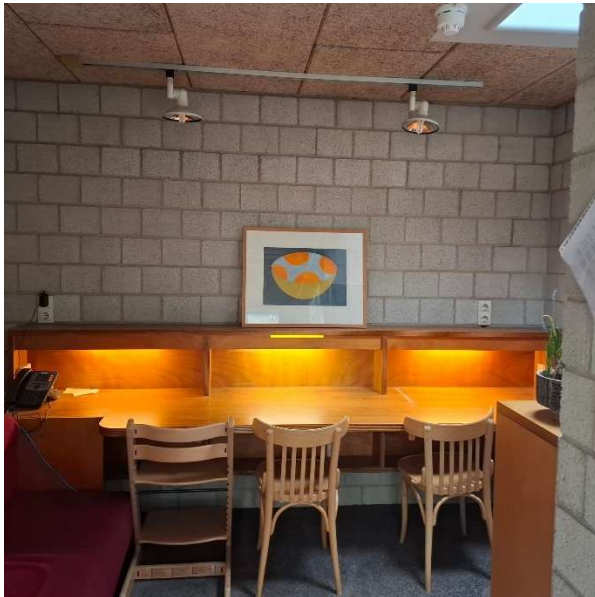


Figure 41: Working space (photo by Amarja)



Figure 42: Display cabinet (photo by Amarja)

## Concept

Hertzberger envisioned the Amsterdamse Montessorischool as a “micro-city”, where interconnected spaces support social interaction and independent learning, an architectural translation of Montessori’s community-based philosophy (Hertzberger, 2008, p. 50). The central atrium with its multi-levels acts like a plaza that links all the classrooms from all the floors together and encourages interaction across different age groups (Figure 11).

Every part of the design supports freedom and focus; from flexible classrooms and quiet nooks to hands-on kitchens and communal areas. The use of concrete and glass creates a sturdy yet transparent environment in which children can feel at ease without being overly visually stimulated.

## Practical implementation and evaluation:

In an interview with Caroline Frehse, deputy director of the Amsterdamse Montessorischool, it became known that this design of Herman Hertzberger really works in practice. The design works according to the pedagogical principles. The atrium improves the feeling of a community and collaboration among the students and tutors; it is a central place where everyone comes together when there are certain activities or certain events at school.

There are some minus points in the design that don't really work so well according to the tutors, such as the material used for the atrium roof. When everyone is gathered in the hall or the atrium and it rains, it can get pretty noisy, and you can hardly understand anyone. Also in the summertime it can get pretty hot in the atrium. When it comes to the classrooms, they are a bit unhappy with the position of the sink. Due to the glass facade, it can become challenging to find the right spot to put closets for storage anywhere. When it comes to some of the furniture, it can get pretty hard/difficult to clean, such as the wooden railings with gaps and the high shelves for extra storage.

In short, Herman Hertzberger designed a Montessori school building that supports the pedagogical principles entirely, and in a unique way you could see that through the atrium, the flexible layout of the classroom and all the furniture. He didn't focus only on the classroom layout and hallways, but he thought about every detail such as the mult-levels, the built-in steps, the gaps in the railings and furniture, in this way the whole building works together as one, like a machine, in which the key pedagogical principles of Montessori are reflected.

## Conclusion

In this research, the main question *“How did the architecture of Dutch Montessori school buildings, in particular spatial design, evolve in response to Montessori pedagogical principles throughout the 20th century?”* is addressed by conducting a literature and case study. The main question was investigated by answering two subquestions. The following conclusions were drawn from this:

1. What were the important Montessori pedagogical principles that influenced the understanding of educational spaces?

Maria Montessori's pedagogical principles brought a fundamental shift in how we should think about learning environments and how they should be designed. Instead of having classrooms that revolve around teachers, she believed that the space should be child-centred and should support each child's natural growth, independence and curiosity. The Montessori method offered a more thoughtful way of designing educational spaces that better support children in doing things on their own. The key Montessori pedagogical principles that influenced the understanding of educational spaces are the prepared environment, freedom of movement and choice, hands-on learning, mixed-aged grouping and uninterrupted periods.

All these principles have a direct impact on the spatial design of the classroom. For instance, accessible child-sized furniture and open layouts with smooth circulation paths encourage autonomy and exploration. Sensory zones with different textures and materials spark curiosity and deepen self-directed learning, while spatial zoning of the space encourages social interaction

and individual focus. Flexible, shared spaces support peer learning and collaboration across different age groups. The colors and storage of the interior are considered to create a calm, inviting space where children can focus on their work. Although Montessori didn't label outdoor spaces as a separate principle, she emphasised the importance of nature throughout her books and philosophy. According to her, outdoor environments are a natural extension of the classroom, offering opportunities for movement, discovery, and a deeper connection with the world around them.

2. How did the Dienst der Publieke Werken (1927), Leupen (1953) and Herman Hertzberger (1983) translate Montessori principles into architectural design elements in their school projects?

The Publieke Dienst der Werken designed the first public Montessori school in 1927, and during the design process, Maria Montessori herself was involved. In short, here is how they translated the Montessori principles into the design:

- Prepared Environment: Spacious classrooms of 95 m<sup>2</sup> with an organised layout and spatial zoning. Large windows for abundant natural daylight and lightweight, child-scaled and accessible furniture. Toilets just opposite of the classrooms and clothing racks in the nooks of the hallway.
- Freedom of Movement and Choice: A Classroom with a flexible layout with smooth circulation paths. Adjacent classrooms are connected through doors in the corner of the room.
- Hands-On Learning: In the back of the classrooms, there are built-in kitchen spaces with low-lying sinks. Organised classrooms with spatial zoning for floor-based activities.
- Mixed-Age Learning: Multi-functional areas in the back of the classrooms for resting, individual work or presentations. A broad hallway of 2.5 m with nooks for collaborative or individual work. Outdoor garden for activities and playing.
- Uninterrupted Work Periods: Warm and light interiors with wooden furnitures. Lots of windows for daylight throughout the building.

Piet Leupen designed the Arnhem Montessori school in 1950 and expanded it in 1953. Here you can read in brief which design decisions the architect made.

- Prepared Environment: Classrooms of 65 m<sup>2</sup> with organised layouts and spatial zoning. Large windows for plenty natural daylight and lightweight, child-scaled and accessible furniture. Toilets just opposite of the classrooms and clothing racks in the nooks of the hallway.
- Freedom of Movement and Choice: Classroom with a flexible layout with smooth circulation paths. Acces to outdoor environment from within the classrooms.
- Hands-On Learning: In the back of the classroom, there is a kitchen space.
- Mixed-Age Learning: A broad hallway of 2.6 m with nooks for collaborative or individual work. The Blue quare and outdoor playground for playing together or meeting each other. Low windowsills turned into seating areas.
- Uninterrupted Work Periods: Warm and light interiors with wooden furniture. Lots of windows for daylight throughout the building.

Herman Hertzberger designed the Amsterdam Montessori school in 1983. And these were his design interventions:

- Prepared Environment: A spacious atrium with multi-levels and built-in wooden steps. L-shaped classrooms with an organised layout and spatial zoning. Large windows and lightweight, child-scaled furniture around the atrium and in the classroom. Spaces created in front of the classroom with clothing racks.
- Freedom of Movement and Choice: L-shaped classrooms with a fluid circulation that are connected to the hallway and the atrium by glass doors.
- Hands-On Learning: Classrooms have child-height kitchens, counters and art stations. In the hallways there are display boxes to showcase the students work.
- Mixed-Age Learning: The atrium and built-in steps for collaborative work or individual work. Nooks and alcoves in the walls to sit together, rest or work individually.
- Uninterrupted Work Periods: Brutalism is reflected in the interior. Daylight through large windows and skylights of the atrium. Warm and light interior with wooden furniture.

Returning to the main question, this research offers many insights into the evolution of the architecture of Dutch Montessori schools throughout the 20th century. From the Dienst der Publieke Werken's Montessorischool de Wielewaal in 1927, through Leupen's Arnhemse Montessorischool in 1953, to Hertzberger's Amsterdamse Montessorischool in 1983, architects reimagined the spatial design of learning environments.

In 1927 the Publieke Dienst der Werken focused more on functional, light-filled spaces with large windows, designing environments that feel like home, where everything is easily accessible.

In 1953 Piet Leupen introduced a more warm, child-centric design with accessibility to the outdoor garden from the classrooms. In this way he designed a more interactive and nature-integrated space compared to the 1920s.

In 1983 Herman Hertzberger designed a central atrium and articulated classrooms to create a micro-city. In this way the building functions as a whole, like a machine.

The evolution went from simple open spaces to more detailed and thoughtful ones. In 1927, the focus was on bright, shared areas that were practical. By 1953, spaces became more flexible and kid-friendly, feeling warmer and more personal. By 1983, designs were complex, with different areas and features that encouraged social interaction and self directed learning that fully matched Montessori's ideas.

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