Veronica Herrmann

**Health supportive interior**

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# Health supportive interior

the power of natural resources inside a school environment

Thesis Interior Architecture

Master of Arts (M.A.)
sept 2021 - july 2023

Referent Thesis: Drs. Marion Zwarts
Mentor Anatomical Model: Wytske van der Veen

MIA
Master Interior Architecture
Academy of Architecture
Maastricht, NL

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Chapter 1

# Introduction

my personal motivation

"Nature—the sublime, the harsh, and the beautiful—offers something that the street or gated community cannot. Nature presents the young with something so much greater than they are; it offers an environment where they can easily contemplate infinity and eternity...Immersion in the natural environment cuts to the chase, exposes the young directly and immediately to the very elements from which humans evolved: earth, water, air, and other living kin, large and small."

**Richard Louv,** Last Child in the Woods: Saving our Children from Nature-Deficit Disorder, p.82

When I feel drained and stressed, I have an inner restlessness that tells me I need to get out and move. Outside, I am drawn naturally to parks, gardens and forests. Letting the sun shine on my face, watching the trees blow in the wind or walking through leaves on the ground calms me down and creates space in my lungs to breathe

in the fresh air deeply and let go of the restlessness. A walk through a forest is pure relaxation for me; I realize that I will always feel that way as soon as I am in a natural environment. Back home I am lucky to look onto large windows on a wide avenue of trees, which gives me a sense of relaxation in my home. Furthermore, plants placed along my window let me get in direct contact with nature and make me feel more comfortable. I think about the fact, that many people are spend all day indoors regularly, in bald rooms without plants and windows or with windows facing other buildings. These people do not get in touch with any piece of nature the whole day. In my opinion, the interior should incorporate more natural resources inside to build a better connection from inside to outside. An interior architect should be aware of the fact that humans spend a lot of time inside and that it is conditioned that the interior not only fulfills a certain function but also significantly increase the well-being and correspondingly the health of people. It does not matter if it is a working, living or recreational space.

In this thesis I work out the influence of nature in the interior on health with a focus on a specific group of people who spend a lot of time indoors during the day and have a high potential to preventively strengthen their health and release stress: pupils in the built environment of a school. As places of learning, schools have the potential to influence generations by employing design strategies that promote their well-being and therefore their early academic success

and positive development in the lives of young people. Pupils are increasingly confronted with many situations at school that they have to master. Often that causes a lot of stress. For instance, relationships with classmates, teachers, and defining one's own personality can be challenging.

Overall, that led me to the following questions: How can more natural resources be integrated into a school environment? How much does this affect the health and well-being as well as the development of a child?

Within the framework of this project I explored the **health supportive interior** - *an interior of a school which integrates natural resources to maintain the health and well-being of the pupils.*

The thesis is divided into three parts:
The first part launches a general discussion of why human beings should always be surrounded by a natural environment. In addition, it is stated how the connection to nature supports a child in health and promotes sustainable development. This development usually takes place in the school, so the closer look is aimed at ensuring that the students have a natural environment close to their learning environment.
The second part of the work is devoted to an architecturally significant example of health supporting school architecture: The open-air school movement, which more than a hundred years ago set out to bring children into a natural environment to combine health enhancement with

the learning concept of a school. this new learning approach was spread to many countries due to its rapid success. The approaches from open-air schools in Germany, Great Britain, the United States and the Netherlands are presented. Subsequently, it is mentioned further if and how the school concept and the learning environment in general are related and connected to the natural environment after the movement stopped until today. In a subsequent discussion, not only the conditions of the outdoor schools are critically examined, but also the advantages and disadvantages are pointed out. It is evaluated which nature related architectural elements were important to strengthen the health.

In addition, the current design approach of Biophilia is explained and discussed, which focuses on the implementation of nature into the built environment, as well as into schools. Examples on biophilic schools around the world are illustrated.
To underline the theory of biophilia, the positive effect on children's health through the implementation of nature into schools is then demonstrated with current, meaningful studies.

The conclusion summarizes the research on the open-air school movement, the biophilic design approach in schools with the proof of scientific research. It results in a conclusion how natural resources can be used in the interior of a school with a large effect on the health of children.

All in all, my aim is to build up the awareness that nature implemented interior design of a school has an impact on pupil´s health, well-being and academic performance. To illustrate architectural elements in combination with educational aspects that can be implemented into a school environment to connect the children more with their natural surrounding. In order to sustainably promote the development of children as an interior architect, it is essential to grasp the health risks of today and, with the help of the knowledge of the connection between the natural environment and health, to design the interior in a way that promotes health.

Chapter 2

# Our connection to nature

Humans, children and pupils

**Humans in a natural environment**

To understand the deep connection of us humans to a natural environment we have to go far back into the past. About seven million years ago, our ancestors began to evolve into the modern humans we are today (Brunet 2002). Since we, humans, as a result of the industrial revolution, moved to an urban environment 200 to 300 years ago, it can be said that we lived 99.99% of our time in nature. Thus, our bodies and genes are adapted to nature as a habitat. The modern world in which we live today is a high stress factor for us that brings us out of balance. Even though the body is adaptable, the incredibly short time in which humans live in the modern world is not enough to adapt the genes to the new environment. Thus, we are evolutionarily rooted in a natural environment. Getting in contact with it helps us still to relax physically and counteract the stress we experience in the modern world.

The transformation of man from the natural environment to move to a modern urban environment brought the positive effects of supply of goods and jobs, protection and security. With urbanization and densification of cities, the connection to the natural environment was lost. In 2013 it was estimated that within 20 years, 70% of the world's human population will live in cities (World Health Organization 2013). The supply of natural areas in cities is often confined. In addition, people spend most of their time inside and due to a strict planned day people´s time is limited, so they no longer have time to go outside and build a connection with nature in their everyday lives anymore.

Furthermore, besides the many unnatural impressions and irritations, the lifestyle of people living in an urban environment causes a lot of stress. Due to the endless possibilities of digitalization and the ever increasing screen time, people are under pressure to perform constantly and always. The stress caused leads to a lower immune defense in the body and therefor leads more often to diseases, that are disproportionately common in cities. These include conditions such as cardiovascular disease, high blood pressure, and obesity (Dye 2008). With the advancement of urbanization, the number of people exposed to the health risks associated with city life increases steadily.

### Children in a natural environment

Children living in an urban environment also suffer from illnesses due to the increased time spent indoors and the resulting reduced physical activity. Outside of school the children spend time in structured activities or with digital devices (Burdette & Whitaker, 2005). So, the missed time outside can be explained by the high rate in screen time and also by the fear of neighboorhood crimes (Gray 2011). The decision or the development that a child is raised more inside is on the one hand the protection from some dangers outside, but other risks are increased simultaneously. This includes risks to physical and mental health, as well as the risk to the ability to interact in a community or to develop self-confidence or recognizing real dangers. Declining contact with nature can itself become a danger if a child can no longer identify with nature (Louv 2013). How then can they become a part of solving today's environmental problems and preserving nature for future generations?

It becomes clear that the contact of children, and therefore pupils, with the natural environment is irreplaceably important. Scientists such as Park, Kaplan and Larouche confirm that experiences and adventures in nature improve cognitive functions (Kaplan & Kaplan 1989), boost mood (Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki 2010) and increase physical activity levels (Larouche, Garriguet & Tremblay 2016). In addition, it is stated that exposure to

nature improves academic performance (Matsuoka 2010), students are better able to relieve stress (Ulrich 1991) and an affinity for natural environments can be built up (Chawla 2007).

**Pupils in a learning in a natural environment**

What is significant in the situation of pupils is that the stress factors at school are manifold. The pressure to perform and the comparison with others on the one hand and the stressful relationships with pupils and teachers on the other hand. With classes take place almost exclusively indoors, these conditions affect not only psychological health, but also social and physical health. The positive effects that a natural school environment can bring, it improves the health of an individual and the school climate as a whole. Due to noise and unsteady weather conditions, it is irreplaceable to have education take place indoors. The integration of natural elements indoors and thereby the creation of a connection to the human`s original environment is fundamental.
In the field of interior architecture, the question is how to maximize the integration of natural resources and bridge the gap between nature and architecture. Considering that the whole school environment influences the pupils, it is necessary to focus the educational concept more on the connection to nature and in combination with the architectural concept to sustainably promote the health, the learning process and the development of the pupils.

Chapter 3

# Open-air school movement

1904-1950

In the architectural history a movement happened that was pioneering for the health of pupils. As initiators architects, doctors and educators worked closely together to create a health supporting learning environment for children connected to outdoors. From 1904 until 1950, the open-air school movement was the world's first attempt to simultaneously cure children of disease or strengthen their health while providing them with the education they need. Means of achieving a healthy, learned and independent child was the open-air cure, a combination of supplying fresh air, light, nourishing food, hygiene, sufficient exercise and the combination of work and rest. Later nature in form of vegetation came more into focus as an important influence on the health of the pupils.

At the beginning of the twentieth century, open-air schools were established in order to cure children suffering from tuberculosis and to take them out of the simple and infectious

environment. This intention was combined with a special pedagogy, because it was feared that the children were lagging behind in their education due to their state of health. The schools were based on the therapy of open-air cure, that was used at that time for tuberculosis patients in sanatoriums. The disease caused the death of one fifth of the patients admitted to hospitals in the 19th century. Because a lack in drug treatments the doctors of the time turned to alternative therapies. Until 1945, when a drug brought a turnaround, the therapy of a healthy diet, hygiene, fresh air, sunlight and regular alternation of rest and exercise was the best alternative. Overall, the open-air school movement became a world movement in the fight against tuberculosis through its quick visible success. Regular congresses were held, which accelerated the spread of the association of medical supervision and a special pedagogy (Chatelet 2008).

In terms of structural and conceptual features, a distinction can be made between outdoor schools, or even forest schools, and open-air schools. In the overall sense, however, the term „open-air school" can always be used. The schools can be located in the forest, by the sea or in the city. At the beginning the schools were planned of the movement for sick pupils, but later on with also schools for healthy, but weak pupils or for completelyhealthy pupils developed.

In the following chapter, I will present the

characteristics of the most important open-air schools in Germany, Great Britain, the United States and the Netherlands in order to provide an insight into how similar but different the concept was realized. Within the chapter I explain the building structure, the daily routine, the pedagogical approach while pointing out the main actors and finally the success of the school concept. The whole concept needs to be understood to see how a child‘s health is affected by the environment and how much architecture, education and medicine are intertwined. Started with the first school of this type in Berlin, the execution is very detailed and further individual aspects of the following schools are mentioned afterwards. The reason for this is that the first school was a prime example for the others, and due to its success, the concept was adopted worldwide.

Following, the similarities and differences of these open-air schools are summarized. Additionally, it is explained how the architecture of the open-air schools supports a school concept to promote the health of children.
Finally, architectural and conceptual aspects in connection to the educational concept are looked at critically from today´s perspective in order to gain insights from the open-air school movement that can be applied to today's concepts and architectures for health-supportive schools.

## Children into the woods - Germany

### Waldschule Charlottenburg (Berlin)

The open-air school movement had its beginning in 1904 in Charlottenburg, a district in Berlin. A special school system was introduced in which children with general physical weakness could be both treated and taught. They mostly suffered from tuberculosis, heart trouble, epilectic, chorea, hysteria, scrofula and contagious diseases (Ayres 1910, p.3).

Before that, the first sanatorium for indigent sick people in Germany was established in 1896 in a suburb of Berlin. This sanatorium consisted of 27 Doecker barracks, invented by the Danish cavalry captain Doecker. It was characterized by a light and quickly assembled construction. A felt mass is placed over a tent-like wooden structure. The dismountable Doecker barracks were the architectural core of the first open-air school (Chatelet 2008).

The open-air school combined a sanatorium with a school that had the following main purposes: The primary aim was to provide a place where children received the necessary education and simultaneously heal from their disease. A sanatorium could not provide this education and attending an ordinary school would only put too much psychological pressure on the children. The introduction of the open-air school was also intended to show that mental life is directly related to physical life.

Mental inability and physical weakness should no longer be considered separately. A further intention came from a more political point of view, as it was in the interest of the government to educate many physically and mentally strong children in schools (Kingsley, Dressler 1917, p. 105ff).

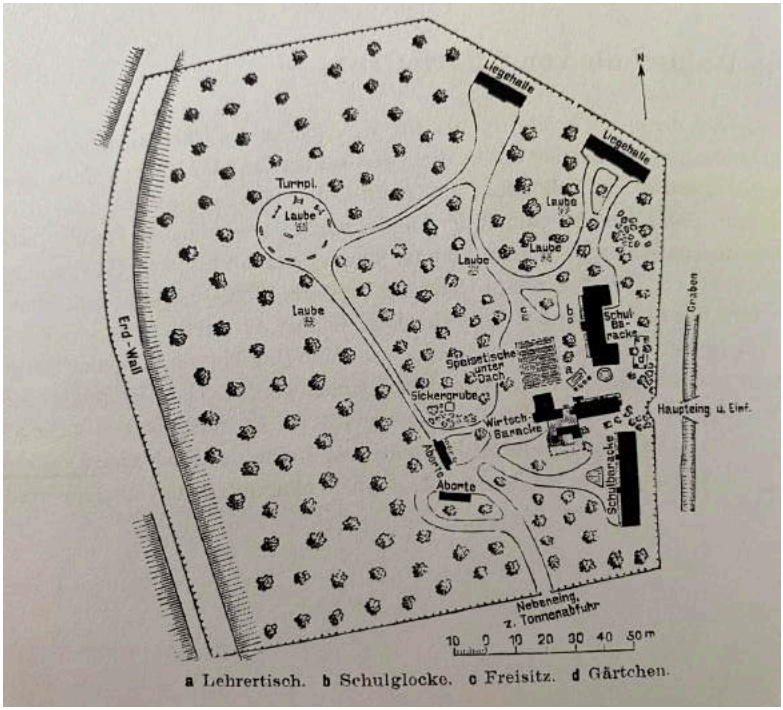
**1/ Main building with classrooms**
Waldschule Charlottenburg 1904

Thus, the world's first school of this movement was the Waldschule Charlottenburg, built on the edge of the Grunewald forest, on an area of eight acres. This location is characterized by the fresh air, the absolute silence and the proximity to nature, which is a relief for the children nerves. The school system is characterized by the fact that the entire daily routine can take place outdoors. This is supported by a combination of medical supervision, sufficient exercise, nourishing food and additionally rest.

The grounds were used as follows:
A total of five main buildings form the school, two school buildings and three large sheds. The one-story school buildings were the Doecker barracks and consisted of two classrooms and two smaller rooms for the teachers and teaching materials. The buildings were closed to the north side and could be opened up to the south side through floor-to-ceiling French revolving windows. They contained heating arrangements and were only used as a classroom in very cold and unpleasant weather (Ayres 1910, p.16). The classrooms, unlike ordinary German classrooms, were equipped with light and foldable desks and chairs to ensure easy carrying out and quick emptying of the classrooms. During bad weather, the classrooms were also used as a dining-, rest- and playroom.
Two of the three large sheds, consisted of a structure of roof and beams, were also open to the south and protected the pupils from heavy showers where necessary. These sheds, featured with tables and benches, were used as the rest area or as classroom in case of rain or too much sun. The last large shed was open to all sides and was placed next to an economic building, to provide space for eating meals outdoors. (Chatelet 2008). Smaller sheds were located all over the ground, which was roofed, to provide a dry space for four to six pupils to read or write during rain (Ayres 1910). The kitchen, the nurse room, the pantry, the restroom and two sleeping apartments were located in the additional building, the economic barrack. Lastly, there existed other small sheds on the grounds

that housed covers for the chairs and desks, as well as materials for free time activities such as reading or sewing (Kingsley, Dressler 1917). A garden was also part of the school, where each child had his or her own individual lot. An outdoor gymnasium provides enough space for gymnastics in the sun and air bath for the whole body. In small arbors the children could quietly and comfortably pursue an activity. Furthermore, it was also important that large parts of the forest retain their original character (Kingsley, Dressler 1917).

**2/ Overall plan**
Waldschule Charlottenburg 1904



The main actors beside the pupils were the school physician, the nurse and the teacher. The School physician dealt with the detailed examination and selection of children to go to the outdoor school. It is based on a determination of the characteristics of these children. After the selection, the permanent medical and nursing supervision of the children during their stay took place. This included the supervision of the nutrition, the clothes that are worn, the tasks that are given and the rest period. Particular attention was paid to the condition of the heart, lungs and general health. Every two weeks each child was weighed, measured and a blood test is made. Height and chest circumference were measured. At the end of the stay, the condition was compared with that at the beginning of the stay. Medicine was rarely administered, as the concept relied entirely on the efficiency of the clean air, the sun and the regulated and nourished life that prevails there. (Kingsley, Dressler 1917) (Ayres, 1910).
The nurse carried out the directions of the physician and was responsible for the primary supervision of the school. This included the cleanliness of the school as well as the meals that were served and the baths that were given. The nurse who was on site day and night (Kingsley, Dressler 1917).

The school day followed a guideline in which nutrition plays an important role. Five meals were served daily. Because school managers could not assume that pupils will receive nourishing meals at home, the school takes respon-

**3/ Lunch in wooded area**
Waldschule Charlottenburg 1904

sibility for them. Each meal was simple but substantial and nourishing. The first thing they had is breakfast. Throughout the day there were 3 blocks of classes, two of which were devoted to instruction and one to play and free time. The order varies depending on the class. After every two hours of instruction with five minutes break every half an hour, the next meal was served. Lunch was followed by two hours of rest. The afternoon was dedicated to free play, after which the day ended with a last meal at half past six. The school was open every day in the week, on Sunday only fewer teachers were on site (Kingsley, Dressler 1917).

After the construction phase of only four weeks in July, the open-air school in Charlottenburg opened for the first period on the 1st august 1904 and closed before winter at the end of

**Daily structure**
Waldschule Berlin

**7.45** BREAKFAST

**8.00** **CLASSES**
*(or play, gymnastics, manual work, read)*
**10.00** BREAKFAST

**10.30** **CLASSES**
*(or play, gymnastics, manual work, read)*
**12.30** DINNER
**13.00** REST and SLEEP

**15.00** **CLASSES**
**16.00** LUNCH

October. Since 1908 the school opened all year except Christmas until Easter because of the cold winters in the German climate. At this time the pupils attended a special school in the city and came back to the open-air school at Easter time.

The teachers at the school were chosen from regular schools but had to execute their duties more informal than before. The relation of the teachers to the pupils was more intimate owing to the fact that they are in company the whole day each day a week. The subjects that were taught were the same as in the regular school and every grade except the lowest is part of that school. As in regular schools, more time was spent in nature singing, studying, doing gymnastics or outdoor games. Bad weather was


**4/ Lunch in open shed**
Waldschule Charlottenburg 1904


**5/ Rest hour after lunch**
Waldschule Charlottenburg 1904

no reason not to hold classes outside: pupils were equipped with blankets against the cold and rain capes against the wet.
The method of teaching was adapted to special needs of the pupils, where health is the focus. Physical well-being was improved or maintained by not applying psychological pressure to obtain certain grades. Encouragement, praise and parental kindness were taught instead of using methods such as punishment, meal denying or exclusion from classes. The help of a teacher was not defined by school hours. If a child needed special help with a subject, there was time outside school (Kingsley, Dressler 1917).

The success could already be seen in the figures of the first year, i. e. after three months: 23 of the 107 pupils were considered healthy, which corresponds to 23%. A further almost 45% improved their state of health, which means that over all the open-air school concept had a positive effect on almost two-thirds of the students (67.8%). Additionally, all of the pupils were able to gain weight. The results achieved were due to outdoor life, sun, baths, medical and nursing care and nutritious food.

Data on educational progress showed that the open-air school and the school the pupils returned to mentioned increased eagerness and alertness, which could not be compared to the status of regular school pupils. On the behavioral aspect the pupils improved in terms of order, punctuality and good temper (Ayres, 1910).
A helpful aspect in this achievement was the

friendly and companionable treatment of the teachers. The direction and discipline of the teachers were also considered helpful. During the attendance the pupils learned how to participate in a group, assist in duties for the community and help each other out.

| disease | Aggravated | *Unchanged* | **Improved** | **Cured** |
|---|---|---|---|---|
| Anaemia | 1 | 9 | 11 | 13 |
| Serofulous disease | - | 8 | 22 | 8 |
| Heart disease | - | 7 | 7 | - |
| Pulmonary disease | 1 | 8 | 8 | 4 |
| Total | 2 | *32* | **48** | **25** |

**6/ Health record after three months**
Waldschule Charlottenburg 1904

All pupils were at the same level of education as those in regular schools. They were able to keep up or even improve their progress after returning to the school in the city. After 3 months they had a further examination, which showed that the results lasted after the attendance in the open-air school (Ayres 1910).

**Waldschule Mönchengladbach**

The new principles of the open-air school were quickly adopted in other German cities. Three schools followed in the next two years. All subsequent ones had in common that they were located in a forest or a park. The basic principle was similar to that of the Charlottenburg school.

The forest school in Mönchengladbach shows its own characteristics: in the Hardter Wald near the city center, four buildings were given the functions of a sanatorium with an administrative building, welfare center for lung patients, forest recreation center and forest school. The wooden buildings were built in the Nordic style, which can be found in Scandinavian countries. The building of the forest school is a simple rectangular structure, which has space for a closed class and a semi-open hall. These were used only in weather, which made outdoor education not possible. They taught weak and anaemic children, suffering from infectious and repulsive diseases. The schedule was similar to that of the Charlottenburg school, except that each child was part of the forest school for only eight weeks. Conversely, with a maximum of 50 pupils, this meant that over 200 children could be cured each year.

The success of the outdoor school in Charlottenburg could be continued in the following schools. The pupils were all able to keep up with the educational level of the regular schools,

they improved their alertness and attention and gained weight. Even after participation in the outdoor school, the success was still noticeable months later. The open-air school education became an integral part of the school system in Germany, following the principles of open-air treatment, nourishing food and medical attention (Ayres 1910, p.25).

**7/ School building**
Waldschule Mönchengladbach 1906

## **Learning in a garden -** Great Britain

The success of the new outdoor school concept quickly attracted the attention of other European educators. Through the report of Dr. Frederick Rose, who had visited the school in Charlottenburg, the London City Council opened the experiment of the first British open-air school in Bostal Wood outside London in 1907. There, 100 anemic and physically debilitated children were taught during the summer months. Children with incurable organic diseases were sorted out. The success of this first school led to the establishment of three other schools in 1908: Birley House, Montpelier House, Shrewsbury House. They were open from June until October, with an average number of 72 pupils (Kingsley, Dressler 1917, p.33). In 1910, these schools were already an integral part of the British school system (Journal of Education 1910, p.118). In comparison to the German schools, the pupils in Great Britain could benefit from exclusive large and well wooded ground, situated on private estates.

**8a/ Outdoor class**
Birley House 1908

The daily routine and basic structure followed the Charlottenburg model, with only minor deviations: The kitchen, dining room, bathrooms and offices were located in the estate. The children spent most of their time under the trees and in the classrooms placed in the garden. Instead of five meals, only three were served. A medical examination took place every two weeks. The course of study was focused on the special relationship with the natural environment.

**8b/ Pupils preparing vegetable**
Birley House 1908

## Birley House

At Birley house a more colonization scheme was followed: Parts that can be found in the ground, like minerals are the subject of teaching. Pupils

**8c/ Rest hour**
Birley House 1908

**8d/ Lesson on sundial outdoors**
Birley House 1908

prospect them and learn in cooperation with other pupils how certain processes can take place, like transport of goods, factories or markets (Kingsley, Dressler 1917, p.133-135). Birley House is an imposing mansion surrounded by large trees in one old fashioned garden. It contains a summerhouse and an orchard classroom. The orchard was presented to the pupils as a sacred trust for the good of the school. They cultivated cabbages and vegetables for their meals. In general, the entire premises of the school is under care of the pupils (Journal of Education 1910, 119). This task not only reinforces the pupil's self-determination and responsibility for self-care, but also instills an empowering group dynamic and cooperation.

The physical results of Birley house were were evident in weight and height gain as well as enlarged breasts. Thanks to the excellent results achieved by the first schools, the open-air school movement in Britain developed very quickly.

Furthermore, also private open-air schools were established in Great Britain, but not for anemic children, in that case for well children. Architects tried to experiment with already existing school structures, to transform them in open classrooms. These conformations were increasing open window space, the removal of one side of a wall, building a veranda or a loggia arrangement (Kingsley, Dressler 1917, p.141). Great Britain, however, has launched a so-called playground classes, which had its beginning

in 1909 in London, but was quickly adopted by other cities. In 1913 there were about 88 playground classes. These are characterized by the fact that different delicate pupils of neighboring schools or pupils from only one school come together as a class and are taught outside throughout the summer. The classes take place in adjacent playgrounds, in public parks or open spaces within walking distance of the school (Kingsley, Dressler 1917, p.142).

### Open windows and roof classrooms - The United States

After the opening of the first open-air school in Providence, Rhode Island, in 1908, the number of this type of schools increased rapidly to 47 schools in 1911 throughout the United States. The schools were established for tuberculosis children. Various stages of the disease were separated, but all grades of the regular schools were admitted.

The location of open-air schools in the United States was to be chosen differently than in European countries. The reason for this was that Forests or parks, which are usually picked as a location, were not available. In fact, space constraints, especially in densely populated American cities, made the choice more difficult. For this reason, cities had to resort to other, increasingly creative alternatives. A good example of this is the Ferry boat Southfield, which was converted into an open-air school.

Also, in New York City, or in other cities such as Chicago, classes were moved to the roofs of (school-)buildings. Others erected tents with wind breaks or curtains, for example at the Graham School in Chicago. Other tents were also placed on the roof. These inexpensive constructions served the function of a classrooms, but besides that a building for the facilities as the kitchen, the dining room, bathing, rest and for the physician was needed (Kingsley, Dressler 1917, p.18). Furthermore, in many cases, regular classrooms were adapted: Walls were removed in whole or in part, windows were replaced with larger ones that could be opened up from floor to ceiling. Another alternative was to use a regular classroom as a cold room. In this case, the windows were kept open at all times and heating was never provided. It was taken care of that the children did not sit in directly air draft. To deflect the air upward screens and ventilators were used (Kingsley, Dressler 1917, 20). Thus, there were 200 cold rooms in New York, the Graham School had 20 of these cold rooms and only a few heated ones, which were used by a few pupils and teachers who could not stand the cold. All in all, a great variety of open-air schools were founded in the united states (Ayres, 1910).

| | |
|---|---|
| Remodeled rooms | 14 |
| Roof classroom | 6 |
| Classrooms with open windows | 5 |
| Boats | 5 |
| Tents | 2 |

**9/ Open-air school structures**
United States

**10/ Remodeled classroom**
Providence 1908

## Providence Open-air School

It was the third year of existence of the Charlottenburg school, so there was not a lot of data for guidance or direction, but the school department of Providence had already shown its progressiveness by founding the first ungraded room in the United States for retarded children. The board members were alive to the educational importance of this new opportunity of rendering real service to children in need (Kingsley, Dressler 1917, 17).

The first open-air school of the United States was situated in a not occupied schoolhouse in town. This brickhouse had to be remodeled by removing the southern wall of one classroom on the second floor (Kingsley, Dressler 1917,

18). The wall was replaced with floor to ceiling windows. The pupils sat with their backs to the floor-to-ceiling window so that the fresh air and light came from behind. The room was equipped with movable desks, chairs and stoves for heating or cooking were installed in one corner of the classroom. On cold days, pupils got their sit in bags at the beginning of the class and they wore them with their outdoor clothing. For even colder days pupils were provided with soapstone footwarmers (Ayres, 1910, 46/47). 28 pupils were admitted in the first school year, it persisted from September 1908 to June 1909. As it was the principal of the school in Charlottenburg, the pupils were selected by a nurse, all of them were exposed to tuberculosis. At the Providence school light gymnastic lessons were

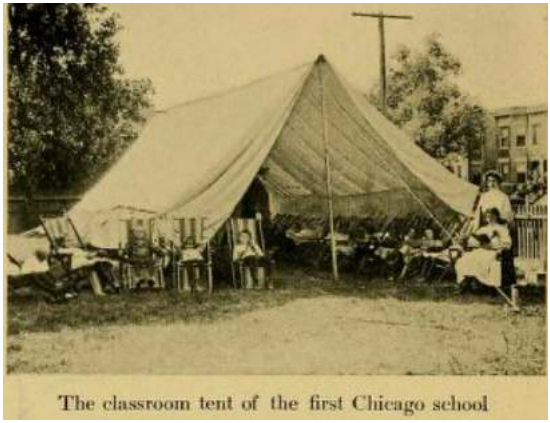

**11/ Pupils in sitting bags**
Providence 1908

given as well as proper methods of breathing. In spring the pupils spent their time working in a school garden, which was a cooperation with other public schools (Ayres, 1910, 50). The success of this school could be confirmed by the constant observation of a doctor. All Pupils developed great from the open-air treatment. The report stated that all pupils except one improved in their health. Furthermore, the average gain in weight was five pounds. Pupils also gained in alertness and truthfulness. After they have been turning back to a regular school, they developed further forward than backward (Ayres 1910, p.51).

**Chicago Graham school**

The first open-air school of Chicago was the Graham school, which provided a tent and reclining chairs in the yard of the regular school. The kitchen and a dining room were installed in the basement of the school. In 1909 classes took place for one month as a summer work for 30 tuberculosis children. The daily program was similar to the program of the other open-air schools: Plenty of air, nourishing food, rest and the regular schoolwork formed the schedule. The results were a clear sign that a year around school had to be realized. All children who had fever, left the class with a normal temperature (Ayres 1910, p.66-67).

Despite all the critical opinions of people in the city, right in the center of Chicago, on the roof of the Mary crane nursery an open-air school




**12/ Tent classroom**
Graham school August 1908

**13/ Roof classroom**
Mary Crane Nursery 1909

was built. It consisted of two structures 4 by 7,5 meter: one tent like built structure for the classroom and one shelter for the rest period. The facilities of the kitchen and the nursery were placed one floor below. The classroom was erected with windows hinged from the top and could therefore be raised and lowered by pulleys and ropes. To protect the pupils from rain and storm it could be closed. When it was warm, some exercises could be done in the fresh air. In this area of Chicago, a lot of children, who lived in overcrowded apartment buildings, needed special care. They even refused to take vacation on Christmas and asked if the school could go on during vacation.

Another school was built on the roof of a neighboring house, the hull house boys club. A Locker room, lavatories, shower baths, toilets

**14/ Exercise Lesson on the roof**
Mary Crane Nursery 1909

and a large resting shed were placed there. With a connection to another roof, both schools could have access to a roof top garden. There the pupils learned how to grow their own vegetables and flowers.

**Southfield boat, New York**

In 1908, the first open-air school in New York was not initiated by the government or the board of education, but by the children themselves. What started as an outdoor camp for tuberculosis patients by Bellevue Hospital became the first open-air school on the Southfield boat. The children collectively demanded a teacher and access to education (Ayres 1910, p.61). Even though a ship is an unusual place for a school, the daily routine and set-up were similar to that of the open-air schools on the mainland. Following the recurring success of the open-air school on Southfield, three more boots schools and one on the roof of the Vanderbilt Clinic were opened (Ayres 1910, p.62).

Furthermore, on December 22, 1909, a conference of medical and school authorities gathered around the Superintendent of Schools to establish new guidelines for the conversion of regular classrooms to open-air classrooms. It was decided what equipment would be needed and how the children would be selected for the classes. So, the new guidelines said that by manually controlling the room temperature, the regular ventilation could be turned off. The minimum temperature should not fall below

50°F (10°C). The equipment should include movable and adjustable chairs and desks and the windows should be covered with venetian blinds. To guarantee fresh air, the open-air classroom should be located at least on the third floor. That height was defined as the level above the dust of the street (Ayres 1910, p.63-64). After the opening of one of these converted classrooms in April 1910, the enthusiasm for this school concept spread so that the park commissioner Stover left pupils from the kindergarten to do their schoolwork in central park or other parks in Manhattan when the weather was nice (Ayres 1910, p.65).

**15/ Classroom on deck**
Southfield boat 1908

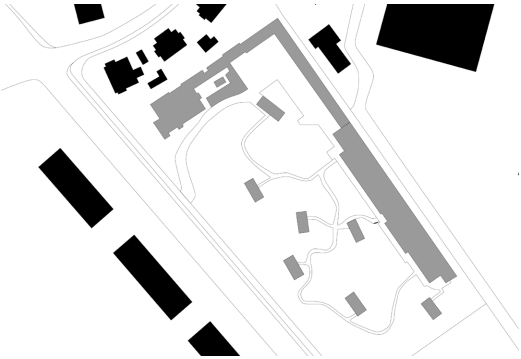
## **From dunes to cities -** The Netherlands

### Outdoor school The Haag

Enthusiasm for the new school concept also spread in the Netherlands and led to the founding of the first open-air school in The Hague in 1913. The school was built in the wooded area of hilly dunes in Scheveningen to help sick children recover with the especially fresh sea air combined with varied food and medical care (Monumentenzoorg Den Haag 2023). Doecker barracks were built, which could accommodate 50 pupils. They included an open dining room, two classrooms and a break hall. In the dunes there were six open learning pits. Preference was given to children with tuberculosis to attend the school. The pupils were taught from May to September outside as much as possible. After a summer period, the children were sent back to regular school and, after examination, their stay was extended for another summer. The intentions of the Dutch schools can be summarized in four areas: Physical education, which includes the aspects of fresh air, rest, cleanliness and good food. Furthermore, moral education, where responsibility and tolerance are taught were mentioned and the intellectual education. Also, the love of nature is transmitted through small gardens, where children learn responsibility to care and study nature more closely (Ayres 1910).

The architecture of the open-air schools was largely based on the barrack construction,

which was realized in 60% of the schools in Germany. In other countries similar values can be obtained. Only in the Netherlands the share of barracks did not predominate. The first open-air school was built as a permanent building in 1911 in Uffculme, Birmingham. The realization evokes the paradox of this architecture: an interior, which is supposed to have the same qualities for teaching as a classroom in the open air. In the school concept of this fixed building type, the most important point of medicine was reduced from a treatment to only a supervision. The classroom became the focal point, and it was now more about integrating nature into the classroom than teaching in nature (Chatelet 2008). The strengthening of health was focused on the relationship with the outside, elements such as good food and rest hours took a back seat. Also, to see the changing structure at the school in The Hague, which switch the focus from nursing to school in 1933 (Monumenten-zoorg Den Haag 2023).



**16/ Site plan outdoor school**
The Hague 1933

**17/ Teaching pits**
Outdoor School The Hague 1913

**18/ Fixed school building**
The Hague 1933

The wooden buildings were replaced with a new building. It is built in a simple design of yellow bricks. The focus is the high, steel glass facades for a bright classroom. The facades have large revolving doors through which it is easy to reach the dunes from the classrooms over a low parapet. The school still acts as an outdoor school and impresses with the high density of vegetation on the school grounds, it is not only beneficial to the students but also to the neighboring residential areas.

Additionally, around the same time the school movement experienced another change in building structure. Due to financial reasons for space and heating, more compressed solutions for health-promoting school buildings were sought. The initial schools of Germany and Great Britain expanded in the woods and open fields, others like in the United States already found more compressed solutions with the open window classes and roof schools.

**Open-air school Amsterdam**

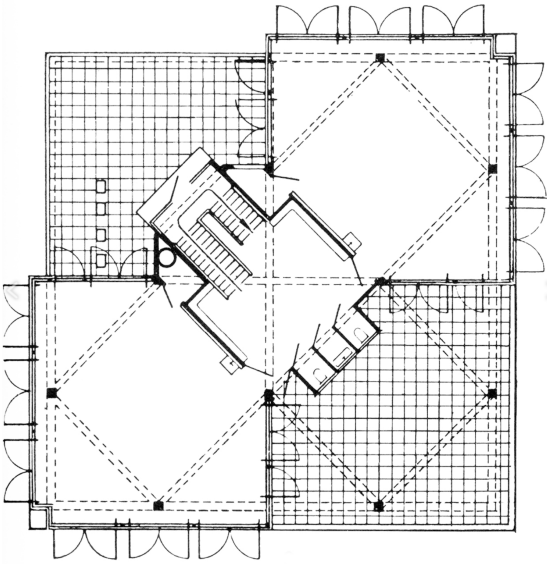
In the Netherlands in 1930, the most compressed school was situated inside a housing block, designed by Duiker and Bijvoet. The, so called, glass cabinet was the first open-air school of the Netherlands and met the conflicting requirements of good flooding of light and air within a dense construction (Chatelet 2008). Also, it was the first open-air school for healthy children. Incidentally, such an open-air school followed a regural teaching pattern, unlike open-air


**19/ Open-air school**
Amsterdam 1930

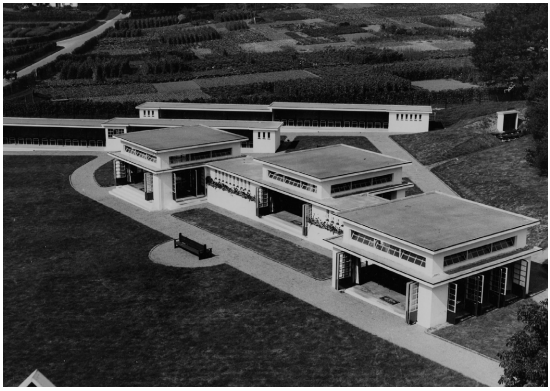
schools for sick or weak children. Therefore, the focus was on the connection from inside to outside to strengthen the health of the pupils. The Association for Outdoor Schools for the Healthy Child considered this project an example for future schools. Open-air schools like this one would eventually replace regural schools in the Netherlands to improve the overall health of Dutch children. The construction of this school opened the detachment of outdoor schools from the anti-tuberculosis campaign (Broekhuizen 2005).

The school consists of a square block with four levels, which stands diagonally on the site. This basic square is divided into four quadrants around a central stairwell. The east and west quadrants each contain one classroom per floor and share an open-air classroom on the south side. The north side receives the administration room on the first floor only. The concrete columns are located in the center of each side, which favorably distribute the forces of the

facades and keeps the corners column-free. This supports the open, floating appearance of the school and clarifies the perceived connection from the inside to the outside that one perceives in the classroom. The school campus is located entirely in the courtyard of a block of houses and is accessible only from the gateway building. This gives the school its own enclosed environment, providing a sense of security and freedom for the pupils in the middle of the city.



**20/ Floor plan**
Open-air school Amsterdam 1930



**21/ Overview**
Arnhem Outdoorschool 1930

## Arnhem Outdoorschool

In the same year as the school in Amsterdam, the architect Van Broekhuizen designed an outdoorschool in the style of functionalism in Arnhem. In comparison it could be built in a not compressed way, all rooms are on one level lined up with a connection in between every room. It consists of four classrooms, which are oriented to the south and partially three walls can be opened (Chatelet 2008). The six-panel glass French doors on the south elevation slide completely away. The urban spot has a high value. It is placed in the middle of the park Klarenbeek, an open and hilly site.

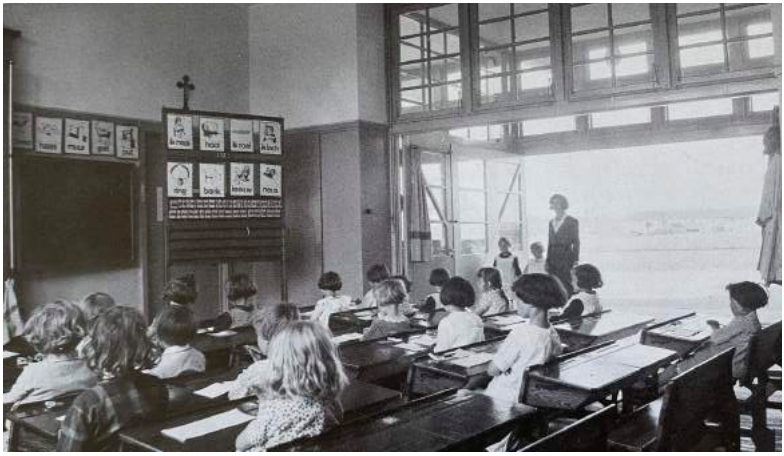
Where the Amsterdam school served healthy children, the Arnhem school was designed for children with long-term illnesses. The schools are both good examples of a school building in

the style of Nieuwe Bouwen with the following characteristics: the focus on the design for entering light and air, realized with facades of large window strips of iron and glass. Typical for the Nieuwe Bouwen are also the functional and clean shapes as the block shape with flat roofs (Rijksdienst 2020).

**22/ Semi-open air school**
Maastricht 1930

**St. Theresia school Maastricht**

In addition, the school in Maastricht from 1930, which is a semi-open-air school, should be mentioned. The building structure is characterized by the seven classrooms in the north-south wing, which can be fully opened to one side by a functional door construction. In doing so, the doors on the east side fold over in sections to different sides; thereby delimiting the corridor but creating a direct connection with the outside. The opposite window front is large and lets a lot of light into the room. The architect



**23/ Semi-open classroom**
Maastricht 1930

Peutz accordingly followed the style of Nieuwe Bouwen and realized a constructively fascinating yet light and open building structure within the open-air movement (Arets, van den Berg, Graatsma 1981).

The shift in focus from Healing and Teaching sick children outdoors to strengthen health of the children inside the school building has led to positive effects. The structural creation of a connection between inside and outside with the availability of sufficient natural light and fresh air promotes learning and corresponds to the image of a modern, industrialized society. Especially in the urban environment, areas that lack of building land and green spaces and where the surrounding stimuli are increasing, children in school need an environment that is invigorating and provides space for learning and development.

**Summary**

*(The sources used are not mentioned again, it is a summary of the previously listed information. Thus, the sources can be found in the previous chapter.)*

With a rapid enthusiasm and quick positive results, the open-air movement celebrated many successes. The interdisciplinary work of architecture, medicine and education shows that the health of a child is based on different facets and that every facet is important. The open-air cure was at the beginning of the 20th century an important and successful means to cure many sick children at the same time as providing them with education. The decisive factors were the combination of a healthy diet, hygiene, fresh air, sunlight, regular alternation of rest and exercise as well as the caring and individual approach of the teachers with the pupils. Later, the focus was on providing sun and fresh air inside a classroom to strengthen the health of healthy children, but this breakdown of factors did not minimize the positive effect the concept had.

It started as an outdoor school, with classes being held outside as much as possible and only when conditions were poor was recourse made to the constructed buildings. The basis of the initial outdoor schools were the Doecker Barracks, which were characterized by their light, movable and fast build construction. Protection from rain and wind was guaranteed, but not

from the cold. If windows were present, they extended from the floor to the ceiling and could be pushed to the side. The furniture was light and foldable to ensure indoor and outdoor use. Later in permanent buildings the classrooms were the center of the schools, equipped with large, openable windows for the connection to outdoors to provide the children with fresh air and a lot of light.

The spread of the open-air school idea resulted in schools in different countries with different types of environments and locations. In Germany, schools were once built on wooded areas, providing pupils with a natural environment outside the city. In Great Britain at that time, there were many large gardens with mansions that offered a lot of green space. It was different in the United States, where the availability of large green spaces was not given or not in short distance, and people already live more in urban areas. There, open-air schools cultivated as roof classrooms, classrooms in tents or on boats. Architects also developed concepts to adapt regular classrooms through interventions: Walls were removed, windows were enlarged. In the United States and Great Britain, one strategy was to relocate some classes of regular schools to nearby parks or open spaces in the summer. In the Netherlands, the change from barracks to permanent buildings took place quickly. With the open-air school in Amsterdam, it was found a sensible, compact solution with still a good flooding of light and air to integrate the open-air school into the city. Many more, and also

healthy children could be brought into contact with a health-promoting architecture.

The success of outdoor schools can be attributed to the combination of the concept-based architecture providing fresh air and light with elements of nutritious food, hygiene, alternation of work and rest. After just a few weeks of attending an open-air school positive effects on the children´s health could already be seen and measured. In many examples, such as that of Waldschule Berlin, a positive effect on the physical health of two-thirds of the children was noted. In addition, a greater willingness and alertness was seen. The students showed more quality in areas such as order, good temper, and participation and cooperation in groups. A very important point is that these positive effects persisted well beyond the duration of attendance at one of these schools. Students who subsequently returned to regular schools did not lag behind, in fact, many of them even improved their performance, while staying physically healthy.

All in all, the movement shows how architecture can strengthen the health of pupils, in close connection with the fields of education and medicine. Depending on the location, different architectural variations developed, but architectural elements that connected to outdoors could be found everywhere. The combination with a health supporting education always brought a positive result for the physical, psychological and social health of the pupils.

## Critical view of today on the Open-air school movement

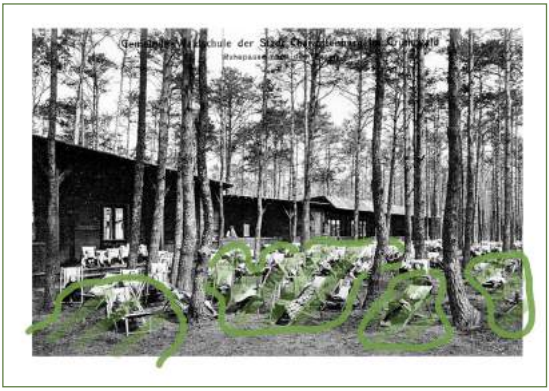
In the preceding explanation and presentation of the open-air school movement and the illustration of some examples a nevertheless deeply positive picture of this school type is conveyed. With high probability the question will arise with the reader why this school type has not spread further. It is to be assumed that the reader has heard for the very first time about it and has not seen it before, because of the remaining appearance of this type of schools nowadays. The reason for this lies in the availability of sources about the movement of the time from the beginning of the 20th century. Mainly advocates are in the role of authors and write about this type of school during the time of the first half of the 20th century in a positive and approving way.

But it should also be looked at critically and reflectively at this type of school and their architectural aspects from today´s perspective and it should be considered how positive the influence on the health and development of the child was or could have been and whether it brought any change at all to the general school pedagogy. For this, it is also necessary to examine why the movement came to an end and how the presence of open-air pedagogy comes to light nowadays. Finally, it is necessary to discuss how the open-air school movement can be a source of inspiration for today‘s schools to strengthen the health of pupils.

First, specific spatial aspects of different open-air school are considered in more detail in relation to the influence on the health of pupils: the first open-air school in Charlottenburg was deliberately positioned in a wooded area to provide the children with fresh air. But a learning space in the midst of nature brings several more advantages: Due to the immediate proximity, the pupil takes in the aspects of nature with all his senses. The visual stimulation combined with the smells and sounds of nature provides a grounded ambience and has a positive effect on the student's mood and well-being. The student gets up close and personal with the movement of plants in the wind, the wandering sun throughout the day, and the changing appearance of nature as the seasons change. Large, open windows let the pupils feel the changes inside as well as beeing outside.

Within the outdoor activities, the natural space is not defined by rigid structures, but more open and closed zones naturally arise, where a pupil can find protection, freedom or even danger and adventure, depending on the need and individually. This strengthens the interaction and identification with nature and through a higher self-confidence, the well-being and health can increase.

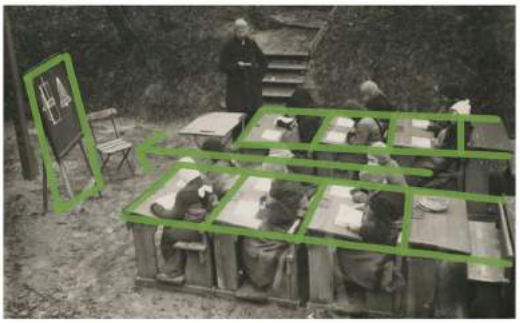
The teaching structure of the open-air schools, however, only found the solution to make the furniture of the interior foldable and portable to the outside. The rigid order of the frontal



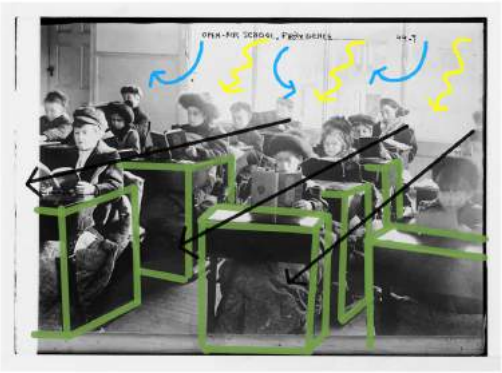
**Zones for protection or adventure which naturally emerge**
Waldschule Berlin

teaching method remained the same, only the setting changed. Even in the open-window classrooms that existed in the United States, the pupil's experience of nature was minimized to the existence of light and air and was considered supportive, while the pupil's experience of space was constrained. In the example of the school in Providence, the pupils could only perceive the sun and air while not even see the source, which they were facing with their backs. To protect them from the cold, their range of motion was restricted by the sitting-bags, and the static furniture of chair and table permanently predetermined their learning position. Even though this unit was flexibly movable, the positioning was similar to that of frontal teaching. Not only the interaction with nature was restricted, interaction with classmates was also limited. The question arises whether the pupil's well-being was more enhanced by the existence of natural light and air than by the static position that restricted them.

The greatest difficulty of outdoor education is the constant exposure to weather and climatic conditions. The aspect of the open-air school movement as health-promoting in the foreground also brings difficulties for the school´s everyday life. The fresh air, which can also enter the classroom as a strong wind, disrupts a calm

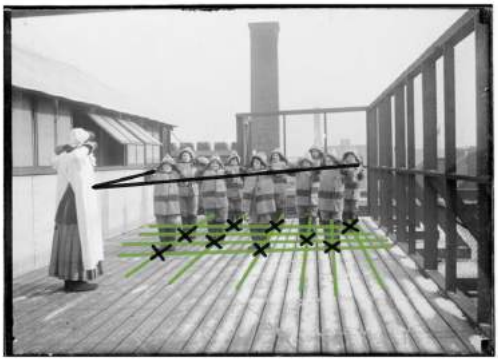


**Rigid teaching structure shifted from indoors to outdoors**
The Hague

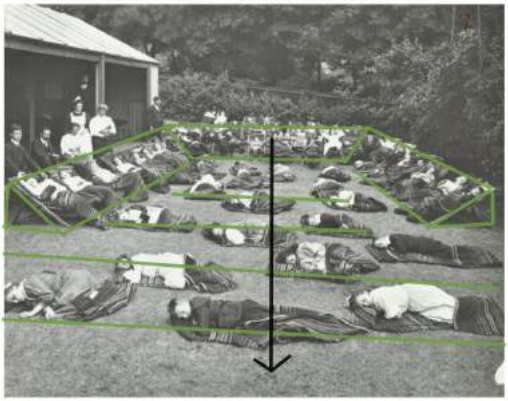


**pupils with sun and fresh air in their backs - restricted in sitting in bags and table-chair element - arranged in rigid order**
Providence

learning environment and can cause discomfort due to temperature and strength. In addition, more in the urban context, when the windows are open, the background noise that does not come from nature acts as a disturbance. Natural light, which has a positive factor on the health and well-being of a pupil, can also be dis-



**Outdoor gymnastic in discipline and order**
Chicago



**Rest hour: Pupils laying on ground in foldable chair, facing one direction, under supervision**
Great Britain

turbing if the visibility of the teaching material is too high. The change of setting to outdoors is putting the pupils out to every temperature range of every season. Because of too cold temperatures in winter, some schools already existed only from Easter to Christmas, because these conditions were unbearable to teach. The temperature has a high influence on the well-being of pupils and therefor their productivity.

Looking at the school day structure of the first open-air schools, a reforming teaching strategy is conveyed, which is also intended to strengthen the individuality and self-confidence and thus the health of the pupils through teaching methods. The relationship of the teachers and students is more familiar and supportive, the activities more varied with a focus on movement, rest and hygiene. What seems to be a looser or freer teaching method, is conveyed as a different impression through the imagery. Even though this type of school refrained from punishments that were otherwise common in schools in the period of the beginning of the 20th century, the activities of rest, exercise and food testify to a clear discipline and pedagogy. With the means of open-air cure, control over health and the space in which pupils move was taken into the hands of the institution. The interest came mainly from the doctors, who at that time wanted to influence the school as a whole through more hygiene and cleanliness (Van der Laarse 1998). Also, with the aim to form the children through their health to

strong and resistant members of society. However, it should be noted that even if these school methods are followed up in a disciplined and controlled manner, the pupils profit in a health promoting way.

From today's perspective, it is clear that the open-air school movement did not initiate a school reform, but rather arose from a medical need and was able to help this need through selected methods. This is probably the reason why in the history of school reforms the open-air school movement is only a marginal phenomenon. In essence, the school system remained the same, the school structure was taken over from the regular school. Only a change of location took place: from the inside to the outside into the fresh air, or: the fresh air came inside. The school processes also remained the same and the space was used in the same way both inside and outside (d'Haenens 1987).

The end of the movement was marked by the elimination of the medical need, which initiated it. With the final discovery of a drug for tuberculosis in the 1940s and the overall improvement of the social conditions at home, the schools were needed less, and the movement which had focus on tuberculosis patients ended. The fact that it did not include a fundamental reform of school concepts meant that this type of school was not pursued further and is therefore not a tangible school concept today.

Nevertheless, it can be said that the open-air school movement at the beginning of the 20th century, as a field of experimentation of the traditional model of education, had a profound importance in the impetus for more modernization and autonomy (Depaepe 1993).

In stating that the movement was not a school reform, the question must be asked from another direction whether the open-air architecture in turn had and has an influence on school behavior. Schools, like the one in Amsterdam, still exist today as open-air schools, but follow a regular school system. The open-air classrooms continue to be used in good weather, and teachers speak of a positive influence on student concentration and interest. The architectural structure thus also influences regular school life today and is an indication that the open-air school movement can be an inspiration for how schools today can support the health of pupils through architectural means.

How it can be an inspiration for present schools, the situation of then and today should be compared:
When the open-air school idea was initiated many children lived in poor, unhygienic districts without the access to clean water or nourishing food. While living in a house with the whole family diseases were spread quickly. Children often suffered from bacterial diseases and chronical issues of the lung and the heart. The medical care was not developed and a lot of diseases could not been cured.

Nowadays, in the western world most children do not lack essential things such as hygiene, nourishing food or a clean home. Medical care is also developed so that there is a drug for almost every illness. But the environment they live in today brings other health problems: the many stressors of the modern, industrialized city combined with digitalization leads to less physical activity and stress for children. They spend a lot of time indoors and mostly on screens. Diseases that occur in relation to this are obesity and mental issues.

All in all, children of the 1930s faced different health circumstances than the children today, but one major commonality can be tapped: the lack of connection to a natural environment and natural resources such as sufficient fresh air, sun and vegetation, which are beneficial to health.

Chapter 3

# Biophilic school design

Designing with and about nature

In the following, with the knowledge gained from the open-air school movement a current design approach is explained, which builds up the awareness for the problem of the decoupling of humans and nature nowadays. The lost connection is a deficit for people's health and well-being. By bringing nature inside, the biophilic design approach builds up the connection between inside/outside and human/nature.

Biophilia means „love of life or living things" (Fromm 1964) and refers to the fact that humans are attracted to everything living and vital. The term first became popular through the biologist and naturalist Edward Wilson's (Wilson 1984) biophilia, who adapted the term into „an innate love of nature" (Wilson 2002), meaning that biophilia is genetically inherited (Kellert 2009). The connection with nature, even in the modern world is essential for the physical and mental health as well as the well-being of people (Kellert 2012). The benefits

come through repeated experiences. The innate tendency to connect with nature works, if it is nurtured and developed by humans (Wilson 1986, Kellert 2012). In the modern world, there is an increasing alienation from the natural world; instead of taking advantage of it, it is exploited. Where the natural habitat in the origin of man was nature, today it is the interior in the built environment. As before, the need for contact with nature is vital to human health and fitness, but it has become a major challenge to achieve this in the built environment nowadays. The reference considered irrelevant shows up inside as insufficient contact with natural light, ventilation, vegetation, views, natural forms, materials and in general beneficial contact with the natural world. The biophilic design approach is addressing the lost reference to nature and creates a principle to make a human feel the nature with all its advantages in the built environment (Kellert 2008).

The benefits of biophilic design range from physical, to mental and behavioral benefits. Physical ones include improved physical fitness, lower blood pressure, greater sense of well-being, fewer symptoms of illness, and better health. Mental benefits range from increased happiness and motivation, to reduced stress and improved creativity. Positive behavioral changes include better coping skills, increased attention and concentration, improved social interaction, and less aggression. The next chapter lists studies that scientifically demonstrate the aforementioned effects.

Schools following biophilic design continue to grow. Bringing nature indoors actively contributes to the mood, physiological health as well as the performance of the students and teachers.

Stephan Kellert, a professor of social ecology, had the greatest influence on biophilic design applicated into the built environment. He defines biophilic design in three categories that represent the kinds of experience humans have of nature. It includes the direct experience of nature, the indirect experience of nature, and the experience of space and place (Kellert & Calabrese 2015). In the design context, the three categories are handed down as nature in the space, natural analogues and nature of the space (Browning et al. 2014).
*Nature in the space* is the actual confrontation with natural elements such as plants, natural light, the air. *Natural analogues* refer to the contact with representation or transformation of natural elements, as well as particular patterns and processes of the natural world. These are natural materials used for design elements and pictures or artworks of natural scenes. Additionally ornamentation, which shape and form are referring to nature. Other aspects are aging, time and geometries. *The nature of the space* refers to spatial settings mimicking the natural world which are beneficial for the human health. These includes prospect and refuge, organized complexity, mobility, way finding and some more.

The categories provide a framework that allows a thoughtful incorporation of a wide variety of strategies into the built environment. The purpose is to create connections between the built and the natural environments and how people react to and benefit from them. Overall, the goal is to create an indoor ecosystem that mimics the outdoor space. Humans should have the urge to interact with all their senses.

## 14 PATTERNS OF BIOPHILIC DESIGN

### Nature in the space

**1. Visual connection with nature**
A view to elements of nature, living systems and natural processes.

**2. Non-visual connection with nature**
Auditory, haptic, olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

**3. Non-rhythmic sensory stimuli**
Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.

**4. Thermal & airflow variability**
Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.

**5. Presence of water**
A condition that enhances the experience of a place through seeing, hearing or touching of water.

**6. Dynamic and diffuse light**
Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.

**7. Connection with natural systems**
Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

## Nature analogues

### 8. Biomorphic forms and patterns
Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.

### 9. Material connection with nature
Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.

### 10. Complexity and order
Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.

## Nature of the space

### 11. Prospect
An unimpeded view over a distance for surveillance and planning.

### 12. Refuge
A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

### 13. Mystery
The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

### 14. Risk / Peril
An identifiable threat coupled with a reliable safeguard.

Terrapin Bright Green framework summarised from 14 Patterns of Biophilic Design (Browning et al, 2014).

**Paul Chevallier School**
Nursery and Elementary school, Techtonics
Lyon/France, 2013

At the Paul Chevallier School, contact with nature is encouraged throughout the space. The design used natural materials such as wood paneling covering interior and exterior walls. This creates a great environment for learning as tactile stimulation can be used for stress relief, energy or relaxation. There is also a vegetable garden on the roof, where the pupils can discover nature through walkable paths. The school is located next to a forest park, so there are views of nature from the classrooms. Floor-to-ceiling windows in hallways and rooms provide more natural light.

27/

28/

29/

**We Grow School**
BIG
New York City/United States, 2018

The We Grow school aims to focus on the abilities of children and to develop their talents at an early stage. A spatial setting of super elliptical objects forms a learning landscape that is free and flowing within the interior. The school includes modular classrooms, tree houses, digital portals and a vertical farm to foster an inclusive and collaborative learning environment. The studio used acoustic clouds, natural materials and neutral colors to create a calm environment for children's focused learning. The school presents a playful and transparent, yet homey and structured space.

30/

31/

**Kakapo Creek Children's Garden**
Smith Architects
Auckland/New Zealand, 2022

Kakapo Creek is an early learning center for up to 100 children based on the idea of symbolically creating a meeting place for people from diverse backgrounds. This idea is reflected in the design of the building, which has a circular shape to create a central meeting space around four main classrooms. The shape of the curve was derived from the shape of the stream that forms the site boundary on the north side of the building and help anchor the building in place. The four classrooms are fully glazed to the outside, creating a connection between the interior and exterior, as well as between the spaces themselves. The design is completed with a glulam roof and a green roof that further connects the spaces below and integrates the building into its natural environment. Extensive greening with native plants promotes biodiversity. Daylighting is maximized through extensive glazing, eliminating the need for artificial lighting during the day. The interior is structured by wooden furniture and wooden floors, as well as a honeycomb construction on the ceiling.

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**The Garden School**
Oliver Heath Design
Hackney/UK, 2017

The Garden School for 4-16 year old with special education needs was expanded to include a recreation room to provide a place for Pupils, who were overwhelmed by the noise and activities on the adjacent playground. Inspired by elements of nature the space contains key aspects: hexagonal seating niches covered in dark blue fabric to calm the children and give them a space of refuge. The private space acts as a cocoon: it reduces the noise and improves the pupil´s concentration. Additionally, window seats for viewing the playground in a position of prospect. Besides, the children are more exposed to daylight. In the back an interactive feature is placed to stimulate the children to work with the sounds and textures of nature. Overall, the space is furnished with visual references to nature: a textured carpet, a wallpaper with

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**School De Verwondering**
ORGA Architect
Almere/Netherlands, 2021

The biophilic school consists of clusters of classrooms that create the learning spaces for students. The alignment creates a natural interstitial space that surrounds the central space. Natural elements and references to nature are incorporated into the structure and design as well as the construction. The building, which is partially covered with a green roof, is surrounded by trees that serve as sun shades. On the roof of the lowest cluster is a partially covered outdoor classroom. It is used throughout the year, so pupils experience the seasonal changes. Sheltered areas have been created within the school building as a place of retreat. Natural elements such as subdued lighting, muted colors, soft furnishings and a beautiful view encourage relaxation and concentration. Large windows and skylights create a good view of nature outside. Indoor and outdoor green facades not only increase the visuality of nature, but also improve air quality and oxygen levels. The ability of students and staff to concentrate therefor rises. In addition, the greenery also acts as an effective sound barrier, helping to regulate acoustics in the classrooms. The large windows and reflective surfaces optimize daylight penetration and create a stimulating environment that increases student concentration, learning and performance levels. Natural materials such as adobe in the classroom or mambo floors in the hallway were used.

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Chapter 5

# Health and biophilic design

Studies on effect of nature on pupil´s health and academic success

Subsequently, this last chapter of my research supports the health-supporting, nature-based architectural structures and methods used in an educational environment on a scientific level with meaningful studies, ultimately clarifying the importance of natural resources inside a school.

Based on the illustrated 14 Patterns of Biophilic Design, studies can prove that they support the stress reduction, the cognitive performance as well as the emotion and mood enhancement of pupils in a school environment.

The beginning of research into health-related outcomes and biophilia was initiated by Roger Ulrich in 1984. He found that patients in a hospital, who could see nature through the windows of their rooms recovered more quickly after surgery. In addition to that, they required less medication than patients who could only see a wall from their room (Ulrich 1984).

Much of the research on biophilia has focused on stress reduction as measured through heart rate, blood pressure, cortisol levels and psychological response. Stress is the main cause for mental and physiological diseases of children in the modern world. The other focus of the research is on the increase of cognitive functions. As early as the 19th century, the landscape architect Olmstedt theorized that the human brain functioned differently in nature (Olmstedt 1865). The brain should act on a level of soft fascination when seeing natural objects. The assumption developed into that of Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989), which states that parts of the prefrontal cortex in the brain come to rest during experience in nature. Thus, there is a better cognitive capacity after a mental break.

**Neuroscience level**

On a neuroscience level the effect of stress reduction is largely through the sense of visual perception. Through the light that is reflected into the human eye, neurons in the brain detect and encode attributes of the visual world. These are attributes like the orientation of contour (Hubel & Wiesel 1968). Exemplary for the feature contour, in the course of evolution the brain is specialized for processing curve linier contours with smoothly varying contour orientation (Field 1993). It should be noted that the natural environment largely contains these forms. As a consequence, it can be stated that biomorphic forms in architecture can be pro-

cessed easier by our neuro system and therefor reduce stress (Joye 2007). This allows the brain to enhance the focus and process other things such as academic material.

**Stress reduction, cognitive performance and perceived well-being**

Studies prove that not only the visual connection to nature, but also the non-visual connection increase pupil´s cognitive performance and perceived well-being.
Auditory or haptic stimuli, changes in air temperature and airflow, the presence of water and varying intensities in diffuse and direct light affect the health of humans and pupils, which hence reduces stress.

In one experiment the view on foliage plants caused the effect of decreased stresslevel due to lower heart and pulse rate. Pupils also stated that they felt better (Ikei 2014). Furthermore, a study testifies that only photos of natural landscapes improve the mood and lowers the perceived stress (Kweon 2008).

The natural resource light exists in nature in different variations such as diffuse and direct light. Over the day the intensity can change rapidly. By mplementing light variations and intensities in a classroom, pupils gain a better well-being and performance in school after a year (Mott et al. 2012). Additionally, the access to daylight causes greater subjective well-being, higher levels of alertness, faster cognitive speed

and better concentration performance (Eitland 2018).

Secondly, the implementation of biomorphic forms and patterns and the material connection to nature into educational spaces are a scientifically confirmed subject for health promotion of pupils. As stated in the beginning, biomorphic forms are easier to process for our brains and accordingly lead to less stress and more cognitive function. If we have contact with wood, it induces also physiological relaxation (Ikei 2017). How spaces of prospect, refuge, mystery and risk, like they exist in nature, have an influence on pupils in the built environment is supported by the following studies: spaces of refuge improve concentration, attention and perception of safety, whereas spaces of prospect not only reduce stress (Grahn 2010) but also enhance comfort (Herzog 2007). It creates a base to increase the productivity of pupils.

**Studies on biophilic classroom design**

In the end, the effects of the biophilic patterns on pupils are shown when they are combined in an educational setting. It is stated that each pattern can already have a health supporting effect in reducing stress, improving cognitive functions and raising the mood, but by combining the patterns it is decisive that the effects are also combined, and the overall health of pupils is guaranteed.

In the first experiment of 2018 the difference of the effect of one non-biophilic classroom and a classroom with biophilic patterns was measured. Pupils spent five minutes in a windowless classroom and the next five minutes in the biophilic classroom with plants, a metal screen with biomorphic patterns and view to the river outside. In this short period of time it could be measured that the biophilic setting caused lower blood pressure and 14% improvement in short-term memory performance (Yin et al., 2018).

The second experiment had the same structure that there were two different classrooms: one biophilic classroom and one control classroom. But the experiment compared to the other one persisted over a whole school year. The biophilic classroom was defined by the view to nature outside, a dynamic and diffuse lightning through sun shades at the window and biomorphic patterns and shapes throughout the room. Through responses in surveys, interviews and biometric testing, pupils in the biophilic classroom were less stressed than pupils in a control classroom. As a determined consequence Math test scores of the pupils in the biophilic classroom were more than 3 times better than those of pupils in the control classroom (Determan et al. 2019).

To sum it up, the biophilic design approach manages to sustainably promote pupil's health and academic success by capturing the properties of nature and consequently mimicking them wit-

**40/ Biophilic classroom experiment**
biomorphic patterns
dynamic and diffuse lightning
view to nature
(Determan et al. 2019)

hin a school environment. The impressive thing is, as the studies show, that even short contacts with nature have a positive effect on the pupils. It is not a big barrier to integrate even small factors of biophilic design in a school. Thus, the importance of nature in the school environment for the health of pupils is not only confirmed by observation, but also by significant medical and sociological studies.

Chapter 6

# Conclusion

The power of nature inside a school environment

As a conclusion I close my research by answering my questions from the beginning.

How can more natural resources be integrated into a school environment?
How much does this affect the health and well-being as well as the development of a child?

First, the open-air school movement was considered, which, out of medical necessity, initiated the implementation of nature in the educational environment. The focus was put on the connection between the outside and the inside, which should act in a health-promoting way. Large windows and glazed doors that could be easily opened let in a lot of natural light and fresh air. The construction opened up more and more to the outside space, making it easier to have classes outside. Movable and foldable furniture was an additional helpful tool. Open-air schools placed in nature or had nature in the immediate vicinity facilitated access and also vi-

sibility. Gardens on the school grounds allowed pupils not only to be kept physically healthy but also to learn and take responsibility through interaction with nature.

By collecting health data, the open air schools were able to accurately demonstrate the improvement in pupils' health. The critical health conditions, mainly tuberculosis, could be counteracted and healing could take place through the integration of natural resources. The architectural means that have contributed to this result are in accordance with the school concept. However, since it became clear in the critical observation from today's point of view that the school concept of the open-air schools did not deviate strongly from the regular school concept in view of the discipline and order, the architectural means are to be given even more meaning and importance for the implementation of nature and therefore the health support.

In my opinion, from today's perspective, it is gratifying to see that visible success was achieved more than 110 years ago through a health-promoting school architecture. It shows all the more that the health and mental development of the pupils can and must be promoted by interior architecture, if one looks at the health problems of the pupils living today.

The ongoing decoupling of man from nature is taken up in relation to school architecture with the term biophilia. The health problems of the early 20th century pupil were eliminated by medical care, but with the modern, digitalized world today, pupils struggle with mental and psychological health problems, making it even more essential than a hundred years ago to focus on the human urge of connecting with nature.

Biophilic school design defines the strengthening of student health by extending the elements that existed in the open-air school movement. Nature is seen holistically, in all facets that include the five senses. Under the category of nature in the space, the implementation of light, air and vegetation is followed by water. The haptic qualities of nature, as well as smell, temperature and cyclical changes are part of the biophilic design.
In general, it is about mimicking nature inside, materially and also in the structure of the space. How pupils react physically to certain arrangements and sensory impressions is anchored in our genes. With this knowledge, a learning environment today can be designed to meet the demands of the pupil, to positively influence health and thus well-being and at the same time academic performance. Studies of today confirm that several aspects in a school environment, that are implementing nature or mimicking natural aspects are beneficial for the physical, physiological, social health as well as the academic performance.

To sum it up, the interior of a school has not only the ability to fulfill the function of a learning environment, it has also the power to sustainably strenghten the health of pupils and their teachers. The key is to support the connection to outdoors and the provision of nature inside the school environment in all the facets that were highlighted.

Various methods and strategies were explained at all levels of sensory perception, with particular emphasis on the implementation of natural resources such as light, air and vegetation.

Even the realisation of one nature connected aspect has a measurable effect on the pupil´s health and performance. Therefor, the maximum of aspects is subsequently health-supporting and should be seen as essential for every school design. Schools have the potential to influence generations by implementing nature in the whole school environment to promote their well-being and thus their early academic success and positive development in their lives.

The interior design of a school has the responsibility to provide pupils with a stimulating, calming, and concentration-enhancing learning environment in which they can naturally reach their full potential in their health and academic performance. This is possible when the interior space promotes human rooted needs. The rooted needs are met perfectly by: NATURE.

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