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STRATEGIES TO COUNTERACT 'NATURE-DEFICIT DISORDER' IN THE SCHOOL ENVIRONMENT FOR CHILDREN

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ABSTRACT

In today's world, dominated by technology, rapid dynamics, and global communication through social platforms, the absence of a meaningful human connection with nature is becoming increasingly evident. The socially active individual gradually transforms into an isolated, withdrawn, and alienated subject, distancing themselves both from others and from their surrounding environment.

This article examines the negative effects of limited interaction with nature, excessive use of digital devices, and the enclosed character of the school environment. These factors lead to a range of psychological and physical difficulties among children, including stress, anxiety, social isolation, reduced physical activity, vitamin D deficiency, and disruptions in healthy development.

Within this context, the concepts of "Nature-Deficit Syndrome" and "Nature-Deficit Disorder" are analyzed as particularly relevant to children growing up in the technological era. Emphasis is placed on the role of the school environment—where students spend a substantial portion of their time—and the need to integrate nature into the educational process. Specific guidelines are presented for transforming existing school buildings through increased daylight, transparency, and enhanced visual connection with outdoor green areas.

Special attention is given to the concept of outdoor classrooms. Various types—stationary structures, mobile units, and interactive green spaces ("green schools")— are discussed, along with the challenges associated with their implementation and use. The article also analyzes opportunities for optimizing the use of natural sunlight within educational settings.

Additionally, a proposal is offered for the creation of a multifunctional, mobile furniture module designed for outdoor classrooms. Its purpose is to facilitate the adaptation of existing school facilities to contemporary educational requirements and to support the restoration of children's connection with nature. Different placement options and functional characteristics of these modules are described, with emphasis on achieving optimal visual and spatial communication between students, teachers, and the natural environment.

KEYWORDS

Nature-Deficit Disorder, School Environment, Outdoor Learning, Outdoor Classroom, Outdoor Classroom Modules

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1. Introduction

The influence of modern technologies on contemporary life and the urban environment is undeniable and remarkably extensive. Today, we exist in constant interaction with mobile phones, tablets, laptops, and computers, which have become an integral part of our daily routines. Within this technologized context, robots and artificial intelligence are entering numerous fields, transforming and partially replacing human labor in manufacturing and service sectors.

This profound technological shift has significant social and cultural consequences, which are most strongly reflected in younger generations. Digitalization encourages a closed and isolated lifestyle; the expression "my home is my castle" acquires new meaning, signifying the creation of an implicit virtual barrier between the individual and the external world. As a result, people—especially children—often become "prisoners" in their own homes, interacting with their surroundings primarily through digital devices. Gradually, this leads to a distancing from nature, which brings about various social, emotional, and health-related difficulties.

Within this digital dominance, concepts such as "nature-deficit syndrome" and "nature-deficit disorder" emerge, describing the consequences of insufficient exposure to natural environments and stimuli. Although this issue affects all age groups, it is most pronounced among children, whose physical, cognitive, and emotional development is closely linked to the presence of natural surroundings.

For young people, access to nature is not merely a source of recreation and play, but a vital component of healthy development. The increasing limitations on outdoor experiences and the rising number of children exhibiting symptoms of nature deficit raise serious concerns about their overall well-being.

The purpose of this article is to explore this issue by emphasizing the importance of natural environments for child development, the relationship between nature and school infrastructure, and the implications of vitamin D deficiency—a critical element for the proper functioning of the human body. In addition, the article considers potential solutions such as the implementation of outdoor classrooms—a contemporary educational approach that can support the restoration of the human–nature connection. These innovative concepts are particularly relevant given that children spend a substantial portion of their time in school settings.

2. New Syndromes in the Contemporary World Related to the Lack of Nature

Nature-Deficit Disorder represents a relatively new and more specialized concept, most often used in relation to psychological and behavioral difficulties arising from the absence or significant reduction of interaction with the natural environment. This term highlights the pathological or dysfunctional nature of the condition and can be interpreted as a form of impaired human functioning caused specifically by insufficient contact with nature. The concept is more narrowly defined and emphasizes the psychological and behavioral symptoms that manifest as a result of a disrupted relationship between individuals and the natural environment.

The idea of a "disorder caused by the lack of contact with nature" gained widespread recognition through the work of American author and environmentalist Richard Louv, who introduced it in his book Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder (2005). In this work, Louv describes the complex psychological, emotional, and physical consequences observed in children who spend insufficient time in natural settings. His primary goal is to draw public attention to the alarming trend of decreasing outdoor activity among children and the associated negative impacts. Since then, the term has been widely adopted in educational, psychological, and environmental fields.

The concept of Nature-Deficit Syndrome is related, but broader. It refers to a condition in which individuals—particularly children—have limited access to natural environments, resulting in adverse effects on their psychological and physical well-being. The term is more general, often used in scientific literature and popular discourse as an overarching descriptor of the causes and manifestations of this growing social issue.

The term "Nature-Deficit Syndrome" was introduced in 2005 by British primatologist and conservationist Valerie Jane Morris-Goodall, who used it to describe the increasingly restricted contact between people—especially children—and natural surroundings, leading to notable psychological and physiological difficulties.

2.1. Causes and Contributing Factors

The causes underlying the emergence of both syndromes are largely similar. In practice, Nature-Deficit Syndrome is more commonly encountered, more widespread, and often serves as the unifying framework for discussing contemporary problems associated with limited interaction with the natural environment.

The primary factors contributing to the prevalence of Nature-Deficit Syndrome include:

• Intensive urbanization and reduced access to green spaces; large-scale destruction of vegetation, deforestation, and the loss of forested areas, compounded by frequent wildfires in recent years.

• Lack of adequate educational programs that introduce children to natural environments, alongside the excessive enclosure of school buildings—a legacy of outdated pedagogical models.

• Social and economic barriers stemming from increasing isolation and the excessive digitalization of everyday life.

• Intensive use of technologies and digital devices, which shape a new, accelerated technological rhythm of living.

• Parents' fears and concerns regarding children's safety outdoors, driven by the perception of urban environments as unsafe or hostile.

2.2. Symptoms and Indicators in Children

Although this contemporary problem is most commonly associated with children, it can also significantly affect adults. The symptoms and indicators, however, are clearly identifiable, particularly among younger populations.

Children experiencing a lack of contact with nature often exhibit:

• Excessive dependence on screens and video games, including pathological attachment to digital devices;

•Insecurity and unwillingness to participate in organized outdoor play;

•Increased susceptibility to stress, anxiety, and depressive states;

•Reduced physical activity and deterioration of overall health;

•Lack of interest in nature and the surrounding environment;

•Pronounced apathy toward real-world events;

•Difficulties in communication;

•Withdrawal, silence, and a tendency toward social isolation;

•Frequent outbursts of anger and aggression;

• Difficulty

2.3. Impact on Mental and Physical Health

The lack of contact with nature has a significant impact on the mental and physical health of children. The absence of natural stimuli leads to elevated levels of stress, anxiety, and depressive states, while simultaneously weakening the immune system and deteriorating overall physical condition. When access to natural environments is limited, children often experience difficulties with concentration, the development of social skills, and the maintenance of emotional stability. Reduced attention during classroom activities can also be linked to this emerging syndrome, resulting from disrupted contact with nature as well as increasing isolation and withdrawal.

These factors further contribute to insufficient engagement in outdoor physical activity, which heightens the risk of overweight, vitamin D deficiency, and the development of chronic cardiovascular diseases. Consequently, limited interaction with natural environments leads to a decline in overall quality of life and hinders the normal, healthy development of children.

3. Vitamin D Deficiency in Children

Vitamin D is one of the essential vitamins required for the proper functioning of the human body. It plays a particularly important role in the healthy development of children, as it supports the maintenance of strong bones and teeth and enhances the immune system. It enables the absorption of calcium and phosphates from food—a process fundamental to the formation and preservation of a robust bone structure.

A deficiency of vitamin D in children can lead to serious health problems, including rickets, a condition characterized by bone deformities, softening, and weakening. Lack of this vitamin often results in reduced immune protection. Affected individuals may experience diminished muscle strength and an increased risk of developing chronic diseases.

The primary cause of vitamin D deficiency is insufficient exposure to sunlight, as the human body synthesizes vitamin D under the influence of UV radiation. In the context of modern lifestyles—where children spend progressively less time outdoors and frequently use sunscreen products—vitamin D levels tend to be low. Maintaining optimal levels requires dietary intake of foods rich in vitamin D or the use of supplements.

4. Strategies for Reducing Problems Associated with Nature Deficit

The contemporary socio-economic context demonstrates that the consequences of technological advancement are logical and, to a large extent, inevitable. The rapid integration of technology into daily life alters established behavioral patterns and traditional notions of a healthy lifestyle. However, this transformation should not be viewed solely in negative terms, but rather as an incentive to improve the environment in which children spend a substantial portion of their day.

Children typically spend around eight hours per day in school across five weekdays. Therefore, it is crucial that the school environment and pedagogical approaches support their mental and physical well-being. Internationally, increasing efforts are being made to transform school spaces and curricula in order to create healthier, more nature-integrated, and developmentally supportive learning conditions.

Despite the proven effectiveness of traditional school structures, numerous studies emphasize that they may have adverse effects on children's development and health due to limited opportunities for interaction with natural environments. This issue is particularly pronounced in Bulgaria, where approximately 90% of school buildings are inherited from a previous socio-political system based on closed educational institutions, strict discipline, and standardization of the learning process.

Nevertheless, this situation presents opportunities for meaningful change through the implementation of outdoor and green-school approaches, which stimulate physical activity, social interaction, and the development of empathy toward nature. Learning in natural settings improves concentration, reduces stress, and enhances the emotional well-being of students.

These innovative approaches require coordinated action among government institutions, school administrations, teaching staff, students, and their families. In practice, this can be achieved through the following measures:

• Optimal use of natural daylight in classrooms through thoughtful architectural planning and contemporary design solutions.

• Designing outdoor areas directly connected to classrooms through transparent walls or large glazed openings, creating visual and functional links with nature.

• Incorporating modern architectural elements such as glass façades, skylights, roof lanterns, and French windows to increase daylight penetration.

• Developing concepts for outdoor classrooms—permanent, mobile, or adapted to various climatic conditions—to support regular instructional activities.

• Creating "nature laboratories" for observing plants, animals, and natural processes.

• Integrating natural environments into the teaching of biology, ecology, geography, and visual arts.

• Establishing school gardens that students can maintain themselves.

• Organizing interdisciplinary activities such as ecological games, hiking excursions, nature observations, and workshops for plant identification and environmental exploration.

• Using sustainable and nature-friendly materials, including recycled resources, wood, stone, branches, and leaves for educational tools and practical activities.

• Applying technological tools—mobile applications, photo and video documentation—for the monitoring and study of natural phenomena.

• Developing educational programs that encourage meaningful interaction between students and the natural environment.

Architects play a crucial role in establishing guidelines for the design and construction of contemporary school buildings, as well as for the development of their adjoining outdoor spaces. This task is relatively straightforward when there is an opportunity for a complete reconstruction of the school infrastructure or the construction of new facilities that meet current standards and the needs of modern educational environments.

The challenge becomes more significant in the case of existing school buildings. In such situations, the key question is how to effectively address emerging social and health-related challenges in order to support the development of a generation characterized by strong mental and physical well-being.

One of the most effective approaches is the creation of outdoor classrooms and the adaptation of the educational process so that a substantial portion of learning activities takes place in natural environments.

Parallel to this, various sun-shading systems can be implemented on building façades to ensure optimal penetration of sunlight into the interior throughout the day.

In this context, the thoughtful modeling of suspended ceilings and the treatment of wall surfaces can further enhance the distribution of daylight and ensure improved visual and lighting comfort within learning spaces.

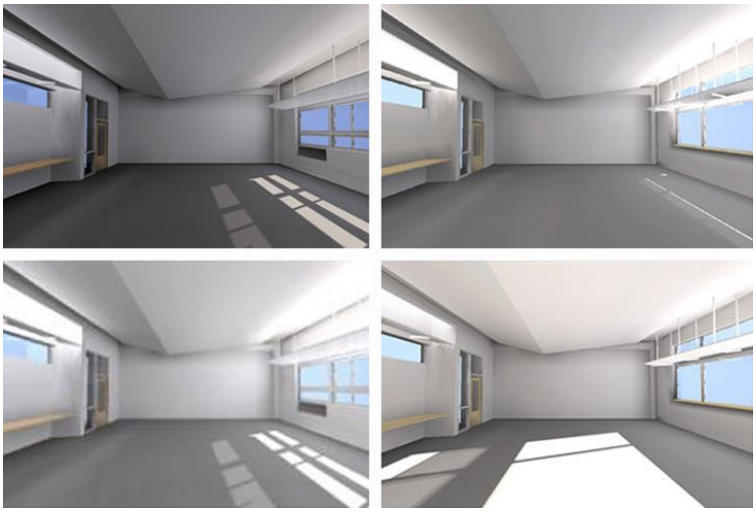


Fig. 1. *Example of the use of a sun-shading device for directing daylight into the interior space*

Fig. 2. *Clackamas High School, Clackamas, Oregon, USA*

During the reconstruction of the façade walls of existing school buildings, it is possible to significantly enlarge the window openings, with the primary goal of ensuring deeper penetration of natural daylight into the classrooms throughout most of the day. However, such an intervention introduces the risk that students seated closest to the windows may be exposed to excessive sunlight and glare.

When classrooms are oriented to the south or east, morning sunlight enters at a low angle and with high intensity, creating pronounced glare. As a result, teachers often resort to lowering blinds or curtains, which necessitates the use of artificial lighting—sometimes for the entire school day. In west-facing classrooms, this issue tends to occur in the afternoon, when the sun is stronger and indoor temperatures rise considerably. Conversely, north-facing classrooms remain dim and poorly illuminated throughout the day.

The amount of incoming light can be regulated through various sun-shading systems installed either on the façade or inside the rooms. In many cases, natural elements—such as pergolas, trees, and shrubs—are also

employed. One of the simplest and most widely applicable methods for controlling daylight is the use of overhangs.

Research (William W. Caudill – *Toward Better School Design*) clearly demonstrates the influence of overhang size on indoor light levels. The provided diagrams analyze both single-sided and double-sided daylighting conditions. As illustrated in the examples (Fig. 3), the presence of an overhang reduces the amount of incoming light and affects the distribution of illumination between the window zone and the opposite wall. When the overhang is significantly extended, the illumination curve decreases and approaches a horizontal line, characteristic of more uniformly daylighted spaces.

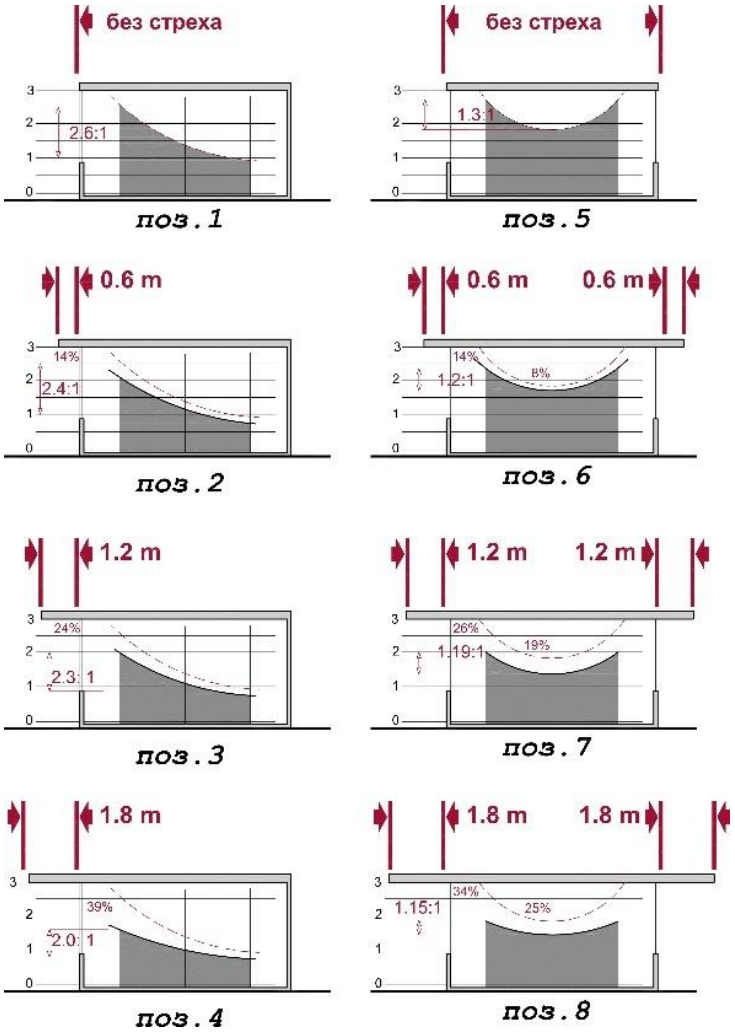


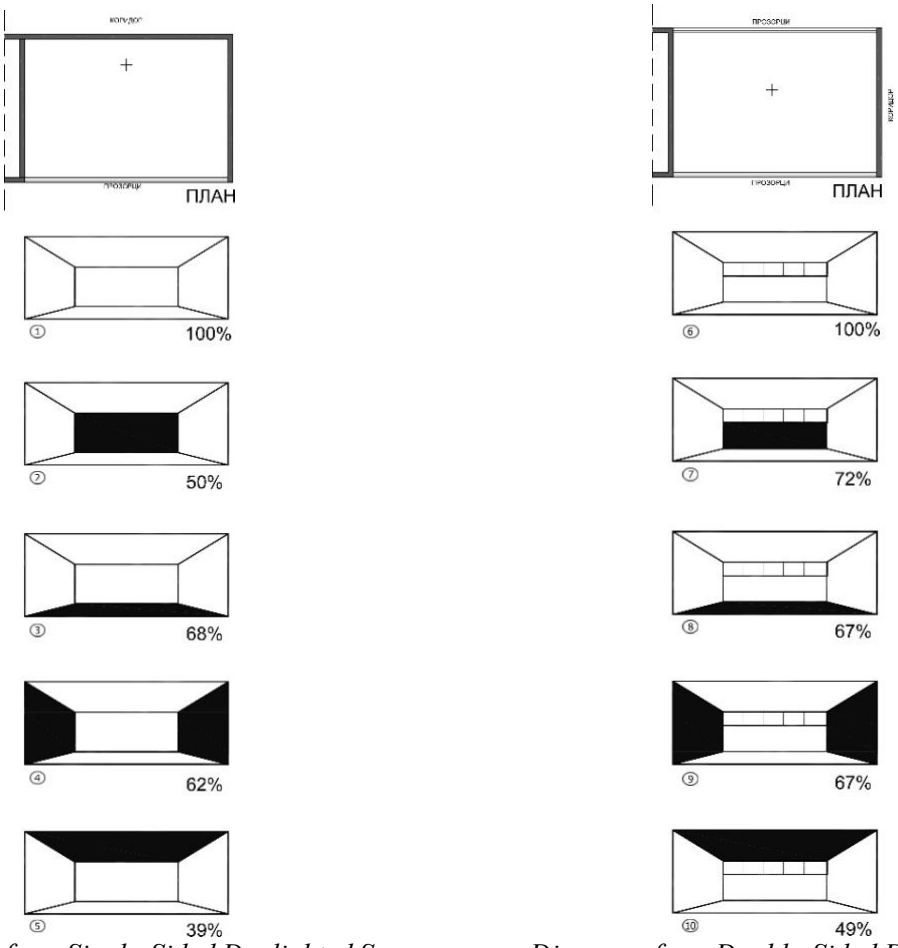
Fig. 3. *Diagrams illustrating the influence of overhangs on indoor illumination level*

In the diagrams from the second column (double-sided daylighted spaces) in Fig. 3, it is evident that as the length of the overhangs increases, the illuminance curve again descends and tends toward horizontal alignment. Nevertheless, the overall amount of incoming light remains higher, and the contrast between the brightest and least illuminated zones is significantly reduced. Such spaces exhibit higher overall light levels and achieve a more uniform distribution of natural illumination across different functional areas.

Natural daylighting in interior spaces is influenced not only by geometry, orientation, and sun-shading elements, but also by the colors of the walls and ceiling. Light inevitably interacts with surrounding surfaces, and their color can amplify or diminish indoor illumination. The deliberate selection of lighter or darker tones can therefore produce either desirable or undesirable effects on the distribution of natural light.

Experimental data presented in the study by William W. Caudill (*Toward Better School Design*) demonstrate specific dependencies, illustrated in the subsequent diagrams for single-sided and double-sided daylighted spaces.

Single-sided daylighted spaces (Fig. 4): The first diagram illustrates a plan of a room with dimensions: width – 6.5 m, height – 3.5 m. The marked "+" point indicates the area with the lowest illuminance level under the conditions examined.



Diagrams for a Single-Sided Daylighted Space *Diagrams for a Double-Sided Daylighted Space*

Fig. 4. *Diagrams illustrating the influence of wall and ceiling colors on the natural illumination of the interior space*

Single-Sided Daylighted Spaces

Position 1 – When all walls are painted white (with maximum reflectance), the illuminance at point "+" reaches 100%.

Position 2 – If the wall opposite the windows is painted black, the illuminance at point "+" decreases to 50% of its original value.

Position 3 – When only the floor is darkened (with all other surfaces remaining white), the illuminance at point "+" drops to 68% of the initial value.

Position 4 – Darkening the side walls reduces illuminance at point "+" to 62%.

Position 5 – When the ceiling is the only darkened surface, illuminance at point "+" decreases most dramatically—to 39% of the original value.

These results clearly indicate that the ceiling color has the strongest influence on natural illumination levels in single-sided daylighted rooms.

Additional analysis reveals:

- A black rear wall causes a 50% reduction in illuminance near that wall and a 9% decrease near the windows.
- A black floor results in a 32% decrease near the wall without windows and a 13% decrease near the windows.
- Black side walls reduce illuminance by 38% near the rear wall and 18% near the windows.

• A black ceiling produces the greatest reduction—61% at points farthest from the windows and 36% at points closer to them.

Double-Sided Daylighted Spaces (Fig. 4)

In a double-sided daylighted room of the same dimensions, windows are added to the wall opposite the primary light source. In this case, the point of lowest illuminance shifts toward the interior of the room (marked with "+").

Position 6 – All surfaces are white, and illuminance at point "+" is 100%.

Position 7 – Painting the rear wall black reduces illuminance to 72%.

Position 8 – Darkening the floor produces an illuminance level of 67%, nearly identical to that in the single-sided daylighting configuration.

Position 9 – Black side walls reduce illuminance to 67%.

Position 10 – A black ceiling reduces illuminance to 49%, a smaller decrease compared to the 61% reduction in the single-sided daylighted room.

Additional findings:

• A black rear wall reduces illuminance by 28% near that wall (compared to 50% in the single-sided case).

• Floor darkening yields nearly identical results to the previous scenario.

• A black ceiling leads to a 51% decrease (compared to 61% in the corresponding point in the single-sided case).

Key Conclusions from the Study

• In single-sided daylighted rooms, the color and reflectance of surrounding surfaces have a substantial impact on natural illumination levels.

• In double-sided daylighted rooms, variations in illumination are significantly smaller. Darkening either the floor or the windowless walls produces nearly identical effects.

• For both single-sided and double-sided daylighting conditions, the ceiling color and reflectance exert the strongest influence on overall lighting conditions.

• Surface reflectance directly affects brightness, illumination, and contrast. In single-sided daylighted spaces, ceilings typically have a reflectance of around 85%, walls around 60%, and floors around 40%.

• In rooms illuminated from more than one direction, the impact of surface reflectance decreases. The more natural daylight enters the room, the less critical the reflectance of walls and ceilings becomes. When daylight is limited, surfaces should have the highest possible reflectance. At the same time, an entirely white room—though optimal in reflectance—tends to create a visually "pale" and "sterile" learning environment.

• From a psychological perspective, warm, light, and clean colors are preferable. Multi-directional daylighting allows greater flexibility in color design, making it possible to balance surface reflectance with principles of color psychology.

• The ceiling is the most critical reflective surface. Darkening it results in twice the reduction in illuminance compared to darkening any other surface. In single-sided daylighted rooms, the rear wall's reflectance is also essential—the area near a dark rear wall may experience up to 50% less light.

• Therefore, single-sided daylighted classrooms should employ surfaces with high reflectance.

• In double-sided daylighted rooms, the influence of surface reflectance is less pronounced, allowing for greater freedom in material and color selection.

Influence of the Human Factor

When designing learning environments, it is essential to recognize that students themselves—through their presence and posture—also affect room illumination and the lighting of individual work surfaces. For instance, a seated student leaning over a notebook can reduce the light reaching the desk by approximately 60%. Traditionally, natural light is expected to fall from the left side of the writing hand; however, for left-handed students, the hand and torso may block the light and reduce illuminance by about 25%.

These effects are additionally influenced by clothing color: lighter clothing increases reflected light and can even enhance overall room illumination, whereas darker clothing absorbs more light.

Therefore, in school building design, it is crucial to account for all factors that influence natural light penetration and distribution—including orientation, architectural strategies, surface reflectance, and the human factor, which forms an integral part of the educational environment.

On the ground floors containing classrooms, it is possible to fully glaze the façades and to provide small courtyard areas directly adjacent to the rooms.

Fig.5. *Original 3D visualization of courtyard spaces in front of classroom rooms on the ground floor.*

5. Outdoor Classrooms

Indeed, implementing the necessary changes, restructuring the educational process, and creating outdoor classrooms present a considerable challenge. An additional difficulty arises from the requirement that these spaces remain functional throughout the entire year and accommodate a variety of academic subjects, pedagogical activities, and different group sizes.

Although outdoor classrooms are a well-established and widely practiced concept in many countries, in Bulgaria the idea is still perceived as relatively new. This is not due to a lack of awareness or interest, but rather to the fact that only a small number of schools possess the appropriate conditions for such spaces. The issue is particularly pronounced in large cities, where schoolyards are limited in size and existing buildings are outdated and difficult to adapt to contemporary educational standards.

5.1. Challenges and Opportunities

Despite the potential for improving the learning environment, several challenges and issues must be addressed:

• **Climatic conditions** often impose limitations;

• **Financial investment** is required for the creation and maintenance of such spaces;

• **Instructional methods** must be adapted to the specific conditions and capabilities of outdoor learning environments.

Identifying suitable locations and redesigning the schoolyard areas—or alternative natural spaces near the school—constitutes an essential step toward the successful implementation of outdoor classrooms.

5.2. Models and Examples

Outdoor classrooms represent innovative educational environments that transform part of the learning process into an opportunity for instruction within a natural setting. Several approaches exist for their implementation:

• **Permanent structures** – the construction of wooden or metal facilities specifically designed for outdoor learning activities. This option is suitable when the school has sufficient unused outdoor space that can be permanently adapted for such purposes. However, within already developed school complexes, this solution is often difficult to realize due to spatial limitations.

• **Mobile outdoor classrooms** – relocatable structures or furniture that can be positioned in various areas of the schoolyard. This approach is considerably more feasible for existing school buildings. It involves the design of mobile, multifunctional, and flexible elements (platforms, benches, desks) that allow for multiple configurations and adaptation to diverse activities.

• **Interactive green spaces** – areas surrounding school buildings that include gardens, zones for observing natural processes, and experimental plots. When located outside the school grounds, this model requires additional time for transportation and coordination.

• **"Green schools"** – an educational practice in which classes are conducted outside urban areas, in natural environments, for extended periods. This approach is widely adopted in several countries.

In countries such as Finland, Sweden, Australia, New Zealand, and Canada, outdoor classrooms are a well-established component of educational systems and are often incorporated into national programs.

Scientific research consistently confirms that learning in natural environments has a positive impact on students. Findings indicate improvements in academic performance as well as in emotional and physical health. International studies further demonstrate that regular outdoor instruction enhances motivation, concentration, and students' social adaptation.

5.4. Challenges and Implementation

Uncertainty and limited resources often hinder the widespread introduction of outdoor classrooms. Additional challenges arise from climatic conditions and the necessity of ensuring student safety. Nevertheless, with careful planning and adequate support, such models can be successfully implemented and can contribute to meaningful, positive transformations in the educational process.

When putting these concepts into practice, it is essential to analyze all characteristics and specific conditions of the given environment in order to achieve an optimal outcome. One of the key considerations is the organization of the space—how the seating modules will be arranged and what type of modules will be used. There are numerous approaches in this regard.

One of the most common methods involves using nature-based elements and readily available materials, without creating specialized furniture for the outdoor classroom. This solution is considerably more accessible and cost-effective. In such cases, the spaces are often improvised, yet this does not diminish the effectiveness of the learning process or the ability to achieve the intended pedagogical goals. A drawback of this approach is that, in many situations, an appropriate working surface (desk) for students to write on is lacking.

Fig. 6. *Source: https://infomreja.bg/kiustendil-sred-gradovete-s-klasna-staq-na-otkrito-134076.html*

Fig. 7. *Source: https://shumenonline.bg/*

The second approach requires significantly more resources. It involves the production of a specialized seating module, often with an integrated writing surface. The most common examples are those in which seating areas are constructed in an amphitheatrical arrangement. These typically consist of solid, stationary structures with limited flexibility for reconfiguring the seating layout and, in most cases, without the provision of a writing surface.

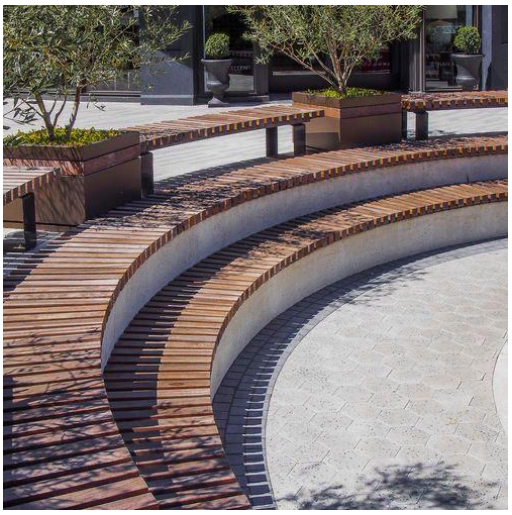


Fig.8. *Source:https://www.archiexpo.com/prod/streetlife/product-51161925444.html*

Fig.9. *Source: https://learninglandscapesdesign.com/projects/colegio-maya-school/*

Fig.10. *Source: https://d.lib.ncsu.edu/collections/catalog/*

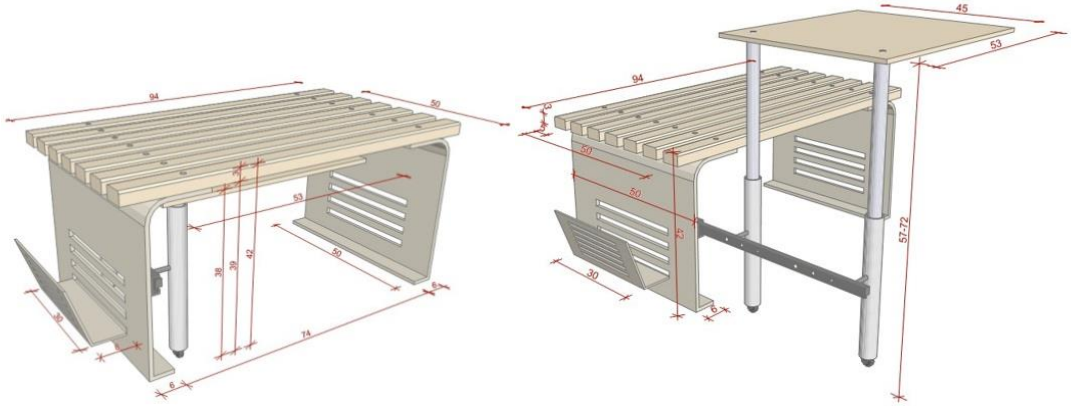
When extended outdoor learning is required across various lessons and subjects, students need to be able to take notes. This necessitates the provision of a module that combines both a seating area and a writing surface. Such a module must be resistant to weather conditions, sufficiently lightweight to allow easy transport, and adaptable to multiple configurations depending on the needs of the educational process. It is also possible to introduce modifications to the proposed product and to employ different materials for its construction.

A New Concept for the Creation of Multifunctional Furniture for Outdoor Classrooms

To enhance the quality of outdoor learning, it is essential to design and develop a seating module that includes an integrated writing surface. The concept aims to produce a module suitable for children of various

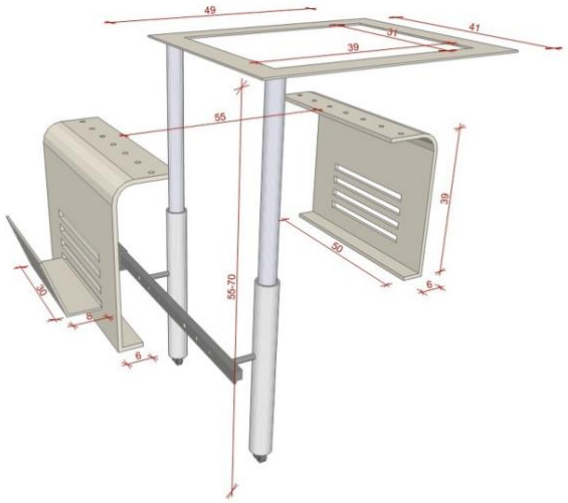
age groups and appropriate for use under different weather conditions. A fundamental principle in the design of such modules is multifunctionality — the ability to allow diverse arrangements and configurations.

The proposed module is offered in two main variants. The first is a single-seat version intended for use by one student. The second is a two-seat version, which maintains the same functionality and comfort as the single model.



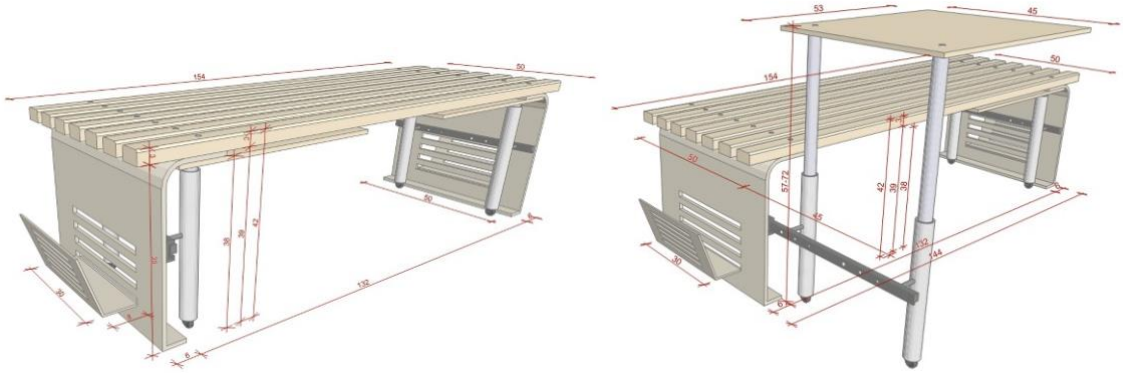
Module with a retractable writing surface ***Module with a pull-out writing desk***

Axonometric view of the single module – outdoor classroom design (dimensions in cm).

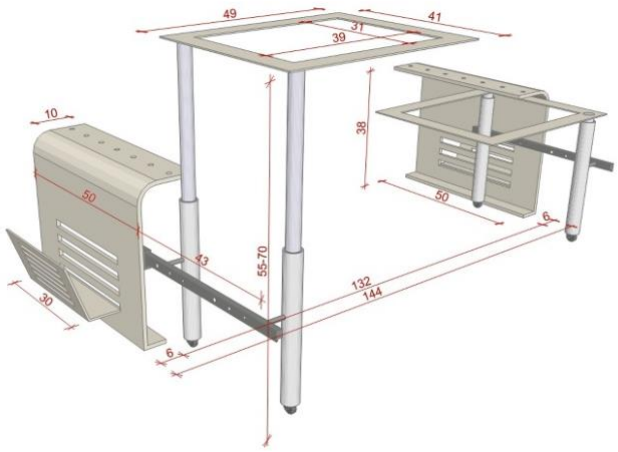


Metal elements (structural model)

Fig. 11. *Author's design of a single seating module with a work/writing surface for outdoor classrooms*



Module with a retractable writing surface ***Module with a pull-out writing desk***



Metal elements (structural model)

Fig.12. *Author's design of a double seating module with a work/writing surface for outdoor classrooms*

With regard to materials, several variations are possible.

• Variant 1

The module features a metal frame. The bench is made of solid wood elements, while the writing surface is constructed from laminated wood. All wooden components are treated to withstand outdoor weather conditions. The writing surface is designed to be height-adjustable, using telescopic tubes that allow multiple elevation settings. To maximize functionality, the module allows the writing surface to be retracted beneath the seating bench, significantly increasing its compactness and flexibility of use.

A dedicated space for placing textbooks and learning materials is integrated into the side support structure. The pull-out mechanism operates similarly to drawer systems and does not require complex construction or additional engineering. The legs of the writing surface are equipped with wheels fitted with stoppers.

The use of wooden elements strengthens the connection between the module and the idea of nature-integrated learning; however, it also reduces its resistance to outdoor weather conditions.

Fig. 13. *Author's design of seating modules with integrated work/writing surfaces for outdoor classrooms, featuring plastic seat and tabletop*

• Variant 2

The second variant represents a lighter-weight solution made from materials resistant to weather conditions. The use of plastic increases the durability of the module and significantly reduces its weight—a particularly important factor given that this is a mobile element intended for use by children.

Regarding the structural components and mechanisms, they maintain the same configuration and functionality as in the initial version.

Examples of Module Placement in Outdoor Classrooms

Within the framework of an architectural project for the "Primary Private School in Sofia," several options for positioning the designed module in the outdoor areas adjacent to ground-floor classrooms for early education have been proposed. Two main configurations are presented:

- **arrangement of single modules;**
- **arrangement of double modules.**

The accompanying 3D visualizations illustrate both the individual and double modules, each equipped with a retractable and extendable writing surface, providing greater flexibility in the learning process

Fig. 14. *Orthogonal arrangement of double and single modules (Author's design for the "Primary Private School" in Sofia)*

Fig. 15. *Arrangement of the two modules (in combination) in a semicircular layout (Author's design for the "Primary Private School" in Sofia)*

The proposed modules allow for the creation of multiple configurations depending on the number of students, the specifics of the educational process, and the preferences of the teachers. This flexibility in arrangement is enabled by the compact dimensions, high mobility, and multifunctional character of the modules, which make them easy to reposition and adapt to various pedagogical scenarios.

6. Conclusion

The impact of global urbanization and digitalization on children is profound and multifaceted, generating significant challenges related to their mental and physical health. The observed issues—including nature-deficit syndrome and the associated health disturbances—clearly highlight the need to reconsider traditional school environments and established educational practices. Integrating natural elements into the learning process not only supports students' overall well-being but also fosters their social engagement and physical development.

The proposed approaches, such as transforming school spaces and implementing the concept of outdoor classrooms, represent innovative and effective solutions to these challenges. By adapting existing infrastructure and creating multifunctional areas that encourage interaction with nature, it is possible to substantially improve the conditions for learning, creativity, and child development.

In conclusion, continued research into the effects of urbanization and digitalization on younger generations is essential, as is the encouragement of active participation from educational institutions, parents, and society as a whole in efforts to restore children's connection with the natural environment. Only through collective and purposeful action can we ensure a healthy, supportive, and sustainable environment for future generations.

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